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Hansa Jain* **and Ram Kumar Jha** ****

Abstract

There is no doubt that the modern technical inputs like chemical fertilizers, insecticides and pesticides, HYV seeds etc. boost up the agricultural productivity. But if these inputs are used in an unbalanced manner, they might destroy the natural fertility of the agricultural farm. The application of these inputs on the farm depends upon the farmer's accessibility and affordability to these inputs, irrigation facilities, technical knowledge and marketing. The study deals with the estimates of farm efficiency and capital output ratio in the districts of Jhansi division in Uttar Pradesh taking the case of marginal, small and large farm sizes.

Jhansi division is dependent on agriculture. There is a vast difference between the socio-economic conditions of farmer's categories. The study is based upon the primary sources of data which are collected with the help of a structured questionnaire and multistage stratified random sampling method.

The technical efficiency is estimated with the help of Cobb-Douglas production function. Categories of technical efficiency are obtained. Chow test is applied to find the difference in the use of inputs among farm categories of different districts. Further, capital output ratio of different farm sizes is calculated.

The study finds that the large size farms are technically more efficient due to the cheaper availability of inputs, irrigation, networking and highly mechanized agriculture. The study emphasizes the need to generate technical knowledge, strong irrigation base and a proper marketing facility. The study also focuses on the joint farming practice by marginal farmers to decrease the capital output ratio.

Key Words: *Technical Efficiency, Capital Formation, Capital -Output Ratio, Hypothesis, Ordinary Least Square Estimators*

JEL Classifications: *Q 11, O 400, C 01*

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1. Introduction

The increasing use of modern technological inputs like fertilizers, pesticides and manure under the condition of unstable irrigation are the responsible factors for increasing the agricultural productivity. The labour input accounts for over 70 percent of the cultivation cost under the traditional method (Rao, 1975). The mechanical inputs like tractor power, threshers, diesel pumps, electric motors save lot of time and human labour. These inputs increase the farmer's and the farm efficiency. As a result, the surplus labour could be utilized in some more productive activity. Besides the increase in farm efficiency increases the production of food grains thus releasing land for commercial crops.

The Indian economy is highly diversified in terms of its geographical, physical and socio-cultural set up. Therefore the technical efficiency is determined not only by its higher production potential but also by its adaptability to given physical, climatic and socio-economic environments. Besides the size of land holdings, farmer's knowledge and skill for the use of modern techniques and their levels of affordability also play an important role.

The producers are unable to utilize the agricultural production factor at an optimum level due to insufficient capital and/ or lack of technical knowledge and this influences the yield productivity and thus income of the producers negatively (Armagan and Ozden, 2007). Kumar et al., (2004) have described that improvements in productivity come from adoption of new technology and increase in the production efficiency. It is well established that the improvements in efficiency are more cost-effective than introducing new technology if the producers are not efficient in the use of the existing technology (Belbase and Grabowski, 1985; Shapiro, 1983 and Dey et al., 2000). If the producers are reasonably efficient, then new inputs and technology would be required to shift the production frontier upward (Ali and Chaudhary, 1990; Ali and Byerlee, 1991). The farm efficiency depends on farmers' management of allocation of available inputs to get the maximum output. Therefore, improvement in technical efficiency is a potential source of further productivity growth (Rao et al., 2003) and it is also important for the reason that without using the existing technology to its full potential, embarking on introducing new technologies is not meaningful (Kalirajan et al., 1996).

2. Concept of Economic Efficiency

Farrell, M. J. (1957) divided the measure of economic efficiency into two components namely (1) technical efficiency, and (2) the price efficiency. Technical efficiency refers to the proper choice of production function by the farms on agriculture. Price efficiency refers to the proper choice of input combination.

Technical Efficiency is purely an engineering concept. According to Henderson and Quandt (1971), "the production function differs from the technology in that it pre-supposes technical efficiency and states the maximum output obtainable from every possible input combination. The best utilization of every particular input combination is a technical note on economic problem. The selection of best input combination for the production of a particular output level depends upon input and output prices, and it is a subject of economic analysis". Technical efficiency is very important because every farm would like to use a 'best' rather than 'average' practice indicating the acceptance of best technology. However technical efficiency is determined by managerial ability, soil fertility, climatic conditions, socio-economic status, market conditions, incentives, price subsidy and price protection, etc. A farm is known as technically more efficient if it produces a large output than others consistently, using the same level of inputs that the other farms use (Raju, 1987).

It is a well known fact that price efficiency maximizes net income or profits. This is possible when the value of marginal product of each variable is equal to its input price. If we consider two farms processing equal technical efficiency having different levels of price or allocative efficiency than the one with the higher profit or net income is relatively more price efficient than the other (Raju, 1987).

A technically efficient farm need not be a price efficient and vice-versa. The farm with higher profits may be relatively more efficient but does not and should not necessarily be a technically or allocatively more efficient than others (Farrell, 1957). The degree of superiority in one type of efficiency may out weigh the inefficiency of the second type and receive higher incomes. If the farm is technically efficient, it would have a lower capital output ratio. The technical efficiency increases the rate of capital formation and vice versa.

3. Important Studies on Farm Efficiency

Bansil (1969) mentioned that the efficiency of agricultural production is directly related to the increasing use of inputs like improved seeds, fertilizers, pesticides, etc., and consider that the amount spent on these items is a part of capital formation. According to him, out of the current income of the agriculturists, a certain portion is set apart for expenditure on manures, fertilizers, etc., this should be treated as a part of capital formation. Besides investment in agriculture, land development, soil conservation, rural roads, agricultural machinery, storage and other items are important ingredients of capital formation, the return from which is expected over a period. He also emphasized on including the investment made on research, education and technical training for the development of human capital since this increases efficiency of the operator leading to increase of output on the farm. Desai (1969) has divided capital into two groups and termed as durable capital (i.e., farm equipments, machineries, irrigation, cattle, cart and farm buildings) and non-durable capital (i.e., working capital under which investment is made on seeds, fertilizers, farm yard manure, insecticides, irrigation, hired human labour, traction labour, field and expenses on milch animals, etc.) in agriculture.

Ghose (1969) classified the investment outlay into two groups: (1) variable capital and (2) fixed capital. The former includes the expenditure on current production inputs, such as seed, fertilizers and manures, pesticides, water and hired labour. The later includes expenditure for the acquisition of land, livestock, tools, equipments and machinaries and also expenditure on construction of house and buildings and land improvements including irrigation work.

According to Mwakalobo (2000), the model $Q_i = AX_i^{bi} \ldots e^u$, provides a compromise between an adequate fit of data, computational feasibility and sufficient degree of freedom for statistical testing. It facilitates the estimation of the marginal resource productivity at the mean level, efficiency measures and the computation of returns to scale. He described that the technical efficiency evaluates the farm's ability to obtain the maximum possible output from a given set of resources. A farmer is said to be technically efficient if it produces as much output as possible from a given set of inputs or if it uses the smallest possible amount of inputs for given levels of output and input mix.

Dimelu et al., (2009) have used the Cobb-Douglas functional form with stochastic frontier production to estimate the technical efficiency of the Cocoyam farmers. Armagan and Ozden (2007) followed the conventional Cobb-Douglas production function to determine the relation between the gross production values obtained as a result of production of selected products and the inputs used. With Cobb-Douglas production function, the production flexibilities can be determined and thereby it facilitates calculation of the input use rates of the enterprises. In addition, it is also effective in determination of income based on scale. Thus, it introduces a different point of view about the productivity concept of the enterprises and determines the input use efficiency putting forth the function of the outputs obtained based on the inputs used. In order to evaluate the efficiency of the farms in Uttar Pradesh and Punjab, Saine (1969) has used the production function approach. He evaluated the allocative efficiency of the farmer by comparing the marginal product of the input factor derived from the estimated production elasticity parameters with their respective costs. He used the gross value of crop output (in Rs.) as dependent variable and land, human labour, bullock labour and expenditure on (a) manures and pesticides, (b) irrigation charges as independent variables. He concluded that farmer's were rational in the use of their resources.

Sahota (1968) in his article has attempted to evaluate the efficiency of the Indian farmers in allocating their available resources among different production alternatives by estimating Cobb-Douglas production function for different crops and farm sizes across different states in India. This is a disaggregative study and he was very careful in the use of econometric methods. However, the main limitation is the use of average data. In his study he concluded that "it would be difficult to defend the often advanced assertions that the Indian farmers are tradition ridden and not rational and economizers or that marginal product of labour is zero". Dey and Rudra (1976) using Cobb-Douglas production function tested the hypothesis that Indian farmers are rational in resource allocation. They rejected the hypothesis of profit maximization under Cobb-Douglas production function. Their main concern is the relative production in which labour and material inputs are used. Hati and Rudra (1973) have attempted to construct an index of technical efficiency and index of allocative efficiency and calculated marginal product of the inputs. Regarding technical

efficiency they found that many of the farms (about 60 percent) produce less than 40 percent of the output produced by efficient farms using the same level of inputs. However regarding allocative efficiency they could not conclude firmly that farmers were allocating resources optimally.

4. A Glance at Jhansi Division in Uttar Pradesh

Jhansi division lies approximately between 24°42' and 26°80' North Latitude and 78°28' and 79°25' East Longitude. It consists of three districts, i.e., Jhansi, Lalitpur and Jalaun. It is really not only the heartland but also heart shaped division of India. It is bounded by district Beena in the north, district Sagar in the south, Tikamgarh and Chhatarpur districts in the east and Shivpuri and Guna districts in the west. The geographical area of the division is 14628 Sq. Kms.

The physical structure of Jhansi division is generally rocky. River Betwa is lifeline of the Jhansi Division. The soil here is developed from the Vindhyan ranges of rocks which in this area are formed of gneiss, granite, quartzite and at times sandstone, limestone and slate. The soil is divided into two broad categories: 1. Black and 2. Red. Irrigation facilities are good in Jhansi division. It has many dams for irrigation and for other purposes. Some of them are Patharai, Dongari, Lechura, Sukama-Dukama, Parichha, Saparar, Govind Sagar, Shahjad, Jamani, Rohani, Sajanam, Rajaghat, and Mata Tila. Prior to these, the main source of irrigation was masonry wells which used to be built by the farmers themselves and 93 percent irrigation used to be done by these wells only. The initiation of canal system had decreased the importance of these wells.

Jhansi Division is highly dependent on agriculture. The water supply is sufficient, so the farmers practice double cropping. The rotation of crops and mixed sowing are also carried out. The system of tillage is primitive. The farmers are using both old and new implements in cultivation. There are two principal crops: (i) The kharif season i.e., the summer crop (from May to October) like rice, maize, kodon, jowar, soyabean, etc., and (ii) The rabi season i.e., the winter crop (from October to March) like wheat, gram, peas, barley, sesamum, linseed, rapeseed – mustard, etc.

A glance at Jhansi division in Uttar Pradesh in table-1 shows that Jhansi division contains about 2.5 percent of the population of the state. The density of

population in Jhansi division (287) is much less as compared to the state average (689). As compared to 1991, the density of population has increased at division and state level. The sex ratio in the whole state is only 898 which is highly unfavourable though it has increased from 876 in 1991 to 898 in 2001. It is only 867 in Jhansi division which is very disappointing. The sex ratio indicates the poor status of women in the society. Literacy rate is also very poor in Jhansi division (60.92 percent) as well as in Uttar Pradesh (57.36 percent). Female literacy rate is only 45.04 percent in Jhansi division and 42.98 percent in Uttar Pradesh.

Social backwardness[1] in Jhansi division is 29 percent which is high as compared to Uttar Pradesh (21.21 percent). The work participation rate in Uttar Pradesh is very poor (32.6 percent) though a marginal increase of 2.87 percent is observed in 2001 as compared to 1991. But the work participation rate has decreased in Jhansi division from 31 percent in 1991 to 27 percent in 2001. Same is the case with rural and urban work participation rates. It seems that the work opportunities are decreasing in Jhansi division and people are moving out for livelihoods. If we look at the condition of agricultural labourers and cultivators it can be seen that in Jhansi division, the percentage of cultivators to total work force has decreased from 60.1 percent in 1991 to 52.8 percent in 2001 and that of agricultural labourers has decreased from 18.2 percent in 1991 to 12.5 percent in 2001. In Uttar Pradesh, the percentage of agricultural labourers has increased from 18.94 percent in 1991 to 25.1 percent in 2001. This might be either due to the availability of opportunities in non-farm sector or insufficient agricultural productivity.

5. Methodology

5.1 Data Collection and Sampling

The study is based upon the primary sources of data that are collected from the Jhansi, Lalitpur and Jalaun districts of Jhansi division of Uttar Pradesh. A pre-tested questionnaire was used to collect the information from farmers of marginal, small and large farm sizes. A multistage stratified random sampling method was used. Depending upon the soil type, one block was selected from

[1] Social backwardness is measured in terms of percentage of scheduled caste and scheduled tribe population.

each district. The field survey was conducted in the two villages of each district for the year 2008-09. The sample design is as follows:

Districts	Blocks	Soil Type	Selected Villages	Farmers Categories	Sample Size	
Jhansi	Babina	Red Soil	1. Dikouly	Marginal (up to 2.5 acre land)	25	75
				Small (> 2.5 acre land to 5 acre land)	25	
				Large (> 5 acre land)	25	
			2. Nayakheda	Marginal (up to 2.5 acre land)	25	75
				Small (> 2.5 acre land to 5 acre land)	25	
				Large (> 5 acre land)	25	
Lalitpur	Jakhora	Rakar Soil	1. Kalyanpura	Marginal (up to 2.5 acre land)	25	75
				Small (> 2.5 acre land to 5 acre land)	25	
				Large (> 5 acre land)	25	
			2. Jamoramaphi	Marginal (up to 2.5 acre land)	25	75
				Small (> 2.5 acre land to 5 acre land)	25	
				Large (> 5 acre land)	25	
Jalaun	Madhogarh	Kabar Soil	1. Kursenda	Marginal (up to 2.5 acre land)	25	75
				Small (> 2.5 acre land to 5 acre land)	25	
				Large (> 5 acre land)	25	
			2. Rupapur	Marginal (up to 2.5 acre land)	25	75
				Small (> 2.5 acre land to 5 acre land)	25	
				Large (> 5 acre land)	25	
Total Sample Size						450

5.2 Selection and Measurement of Variables

In order to explain the variations in total agricultural output in the selected region, the following variables are selected:

Dependent Variable : Gross Output (Y)

The gross output or returns have been defined as the sum of gross output of each crop (in Rs.) at their respective market prices irrespective of being consumed, sold or maintained in the stock. In the present study, the output is converted into monetary terms by multiplying the physical quantity produced with their respective prices prevailed during 2008.

Independent Variables

(a) Investment on Land Preparation (X_1) :

Operational holding is an important determinant of the farm size. Before sowing, it is prepared with suitable number of ploughing according to the concerned crop and soil requirement. In order to determine the total investment on land preparation, the investment incurred on both rabi and kharif seasons is taken into account.

(b) Investment on Irrigation (X_2) :

It is calculated by summing up the various expenditures incurred on irrigating the land during the year 2005. It also includes labour cost and diesel cost.

Variables X_1 and X_2 also include rental value of tractor, diesel pump sets, thresher, trolly, cultivator etc. which are used for land preparation and irrigation. The actual value of these machines is not included as most of the farmers use it on rent.

(c) Miscellaneous Investments (X_3) :

Miscellaneous investment includes expenditure on farm implements, draft animals, threshing and labour costs.

(d) Investment on Seeds (X_4) :

High Yielding Variety (HYVs) of seeds is the important part of modern technology. Due to their different varieties, investment on seeds is calculated on the basis of actual quantity of seeds utilized on the farm multiplied by the respective price of the concerned crop. The value of owned seed has been imputed on the basis of local prices prevailed at the time of study.

(e)Investment on Farm Yard Manure, Fertilizers and Insecticides and Pesticides (X_5) :

Farm Yard Manure (FYM), fertilizers and insecticides and pesticides are critical inputs in agricultural production. They nourish the soil and protect the crops from the insects and pests, which enhance the agricultural production. As a result, productivity of agriculture is boosted up even in the short period. The continuous use of land for agriculture severely deteriorates the fertility of soil. Therefore, these inputs, among others, are the most important inputs for increasing agricultural productivity. The physical quantity of fertilizers and insecticides and pesticides used on the farm were multiplied with their respective market prices at the time of survey. The value of FYM is evaluated at the imputed price actually prevailed in the study area.

(f) Proportion of Family Members having Education up to Primary (X_6) :

Education plays an important role in decision making. Now a days, various government and non-government organizations are involved in providing skill to the farmers to raise the agricultural productivity. Apart from this, various pamphlets and hoardings are also used for awareness generation. The newspapers and radio and television channels add to the knowledge. It can be said that educated farmers will be able to take the benefits of the capacity building programme to the maximum extent. Due to the backwardness of the rural area, the proportion of family members educated up to primary level is taken into account.

(g) Farm Machinery (X_7) :

The use of farm machinery depends upon the farmer's level of affordability. There are the farmers who are better off and can purchase their own farm machinery like tractor, diesel pump sets, etc. There are also the farmers who cannot afford these machines. They hire it on rent. Therefore, in order to avoid the inconsistency in the sample data, dummy variable is used, i.e., the farmers who own these machines were assigned the value 1 or otherwise 0.

5.3 Measurement of Resource Use Efficiency through Cobb-Douglas Production Function

The Cobb-Douglas production function does not distinguish between technical efficiency and allocative efficiency (Sampath, 1979). It ignores the problem of technical efficiency by assuming that all the techniques of production are identical across farms and as such it assumes that each farmer is technically efficient,

which many a time is untrue (Jayaram et al., 1992). The frontier production function defines potential output that can be produced by a farm / firm with the given level of inputs and technology. This function is built around the concept of efficiency adduced by Farrell (1957). Timer (1971) operationalised the concept of imposing a Cobb-Douglas type specification on the frontier and evolved an output based measure of efficiency. In the present study, the Cobb-Douglas type of production function in the form of Ordinary Least Square (OLS) estimation is specified as:

$$Y_i = f(X_i)e_i^{ui}$$

or

$$LnY_i = Ln\beta_o + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 X_{7i} + U_i \quad (I)$$

Where,

Y_i = Total Annual Agricultural Output (In Rs.)

X_{1i} = Investment on Land Preparation (In Rs.)

X_{2i} = Investment on Irrigation (In Rs.)

X_{3i} = Miscellaneous Cost (It includes Investment on Draft Animal, Threshing and Labour cost, Phawada, Gaithi, Khurpi, Hansiya) (In Rs.)

X_{4i} = Investment on Seeds (In Rs.)

X_{5i} = Investment on FYM, Fertilizers and Insecticides and Pesticides (In Rs.)

X_{6i} = Proportion of Family Members having Education up to Primary level

X_{7i} = Farm Machinery (Dummy variable, Own = 1, otherwise = 0)

U_i = One Sided Error Term Used to Estimate the Technical Efficiency

β_0 = Intercept

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ = Production Elasticities

In the next step, the OLS estimators are converted into Corrected Ordinary Least Square (COLS) estimators. In order to obtain COLS estimators, the intercept is adjusted by shifting the function until no residual is positive and one is zero. This is done by adding the largest error term of the fitted model to the intercept, thus yielding the frontier production function (Kumar and Bisaliah,

1991; Greene, 1980; Aigner and Chu; 1968; Timmer, 1971; Richmond, 1974; Sharma and Sinha, 1995; Jha, 2007). The COLS model is:

$$\hat{Y}_i = Ln\beta_o + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 X_{7i} + \hat{U}_i \quad \text{(II)}$$

and

$$\hat{U}_i = LnY_i - (Ln\beta_o + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 X_{7i})$$

or

$$\hat{U}_i = LnY_i - \hat{Y}_i \quad \text{(III)}$$

Where,

$\hat{Y}_i$ = Estimated Output per Acre (Potential Output)

$\hat{U}_i$ = Estimated one sided error term used to estimate the technical efficiency

Now,

$$(-\hat{U}_i) = LnY_i - [(Greater\ Value\ of\ \hat{U}_i + Ln\beta_o) + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 X_{7i}] \quad \text{(IV)}$$

Using the above equation (IV), technical efficiency (TE) of the i-th farm is derived as :

$$TE = \exp(-\hat{U}_i) \quad \text{(V)}$$

and

$$\text{Percentage TE} = [\exp(-\hat{U}_i)] \times 100 \quad \text{(VI)}$$

In the next step, on the basis of percentage TE ranks are recorded for each farm and one of the farms has secured 100 pecent which is considered as most efficient farm.

5.4 Test of Technological Equality: Chow Test

To examine the technological equality between Jhansi, Lalitpur and Jalaun districts of Jhansi division in Uttar Pradesh Chow Test has been used (Koutsoyiannis, 1977). The formula is:

$$F_c = \frac{[\ e_p^2\ (\ e_1^2 \qquad e_2^2)]\ /\ k}{(\ e_1^2 \qquad e_2^2)\ /\ n_1 \quad n_2 \quad 2k}$$

Where,

e_1^2 = Residual sum of squares of first region data.

e_2^2 = Residual sum of squares of second region data.

e_p^2 = Residual sum of squares of pooled data (combined first and second regions)

k = Number of parameters including intercept (k = 8)

n_1 = Number of observations of first region (n_1 = 50)

n_2 = Number of observations of second region (n_2 = 50)

Null Hypothesis (H_0): $b_2 = \beta_i$, that is there is no difference in the coefficients obtained from the two regions. If $F_c > F_t$ (F calculated value is greater than the F tabulated value) then the null hypothesis would be rejected and the alternative hypothesis would be accepted.

6. Results and Discussion

6.1 Profile of the Respondents

In Jhansi division, as a whole especially for small and large size farms, the percentage of farmers is increasing with age. The maximum number of farmers is found to be in the age group 51-60 years and after 60 years, the number has decreased. It seems that during the initial stage of their working age, they try to find jobs in other sectors. Sometimes the young members of the family migrate

for employment. It may also be possible that with the degradation of environmental condition, the cost of production increases. As a result, the elderly people also join the agricultural work force. For the marginal farmers, the similar situation was observed up to the age of 50 years. The average family size is 4-6 members per family, very few of them were having 7-9 members in the family.

The sample was randomly selected without taking into consideration the caste wise and sex wise differences. On the basis of the surveyed farmers it can be said that the majority of scheduled castes (SC) and other backward classes (OBC) are the owners of marginal land while majority of general category farmers own large sized land. The surveyed farmers are earning income both from the farm sector and non-farm sector (Table-2). The livelihood in farm and non-farm sector is found to be high in Jhansi district as compared to Jalaun and Lalitpur district. In Jhansi district, the dependency is relatively high on the farm sector, while in Jalaun, the dependency is relatively high on the non-farm sector. The Lalitpur district has almost equal share of farm and non-farm livelihood. The main source of income generation for all the marginal, small and large farm owners is from agriculture and allied activities. It is only for the marginal farmers that the contribution of non-agricultural activities in total income is high. Due to less agricultural productivity, they have to depend on other sources of income. The contribution of agriculture income to total family income is increasing with increase in farm size (Table-3). This implies that more the agricultural income, less is the dependency on other sources.

The level of education among the respondents (Table-4) is found to be according to their economic condition. A high percentage of large farm size farmers (29.30 percent) are found to have achieved education above secondary level while for small and marginal farmers, it is only 21.68 percent and 11.66 percent. About 44.66 percent of the marginal farmers, 38.50 percent of small farmers and 31.97 percent of large size farmers are literate upto primary level.

Among the surveyed farmers, a total of 252.99 acres land belong to marginal farmers, 597.96 acres land belong to small farmers and 1629.06 acres land belong to large farmers (Table-5). During the rabi season, wheat is found to

be main crop for cultivation followed by gram, peas and masoor. As a whole, the marginal farmers use about 66 percent of land for wheat cultivation, while small and large farmers use 52 percent and 51 percent of their land for wheat cultivation. Among the surveyed districts, Lalitpur is using the highest portion of its land for wheat cultivation. The majority of large farmers leave their land as fallow. This comprises 10.13, 1.98 and 17.53 percent in Jhansi, Lalitpur and Jalaun districts respectively and 10.25 percent in Jhansi division. The main reason behind this is to regain land fertility. By keeping the land fallow, the large farms could be maintained properly. Due to the major portion of land under wheat cultivation, the production of wheat is high in the whole Jhansi division followed by Gram and Peas (Table-6).

For the Kharif crops (Table-7), as a whole, more land is used for the cultivation of Urad followed by moong, maize and groundnut. But the district wise distribution of land does not match with the division. At the district level, in Jhansi district the land under groundnut cultivation is high while in Lalitpur, the land under maize cultivation is high and in Jalaun, land under Urad cultivation is high. Accordingly is the production of various crops (Table-8). In the Jhansi division the production of Urad is relatively high followed by moong, maize and groundnut. At the district level, Jhansi has the highest production of groundnut, Lalitpur has the highest production of maize and Jalaun has the highest production of Urad. Apart from the cereals, Jalaun is also producing sugarcane. Jalaun is the only district in Jhansi division which is the producer of sugarcane.

The data on income and expenditure on agriculture is also collected from the respondents (Table-9). The cost inurred by marginal farmers on agriculture is low in Jalaun and highest in Jhansi. The cost incurred by large farmers is lowest in Jalaun and highest in Jhansi. On the other hand, for all farm size categories, the income earned is highest in Jhansi and lowest in Lalitpur. As compared to other districts, in Jhansi, the marginal farmers are spending more and earning more from their farm while the larger farmers are spending less and earning more from their farm. On the other hand, in Lalitpur, the large farmers are spending more and earning less. The high expenditure by marginal and small

farmers on animals indicates their economic dependency on draft animals (Table-10). In Jhansi district, marginal farmers are spending heavily on draft animals. In Lalitpur, both marginal and small farmers are spending more on animals. The large farmers are spending less amounts on draft animals. This implies that they are able to practice mechanized agriculture. In Jalaun district, the animal power is not at all used for agriculture.

Regarding the expenditure on animal driven implements (Table-11), the total expenditure by small farmers (Rs. 108.15/-) is more than the marginal (Rs. 41.70/-) and large (Rs. 26.80/-) farmers. In terms of percentage, marginal farmers invest about 60 percent of their total investment on wooden plough and 33.81 percent on bullock cart. Large farmers invest 50 percent of total investment on wooden plough and 42.04 percent on bullock cart. While small farmers invest 48 percent on wooden plough and 40.50 percent on bullock cart. The farmers of Jalaun are not using any of the animal driven implement. Human driven implements (Table-12) are used by all the farmers irrespective of the farm size. In terms of percentage, marginal farmers spend more on Khurpi, Phawda and Hansiya while large farmers spend more on Iron Pacha and small farmers spend more on Gaithi and Wooden pacha.

Among the surveyed farmers, the total expenditure on own agricultural machines (Table-13) is maximum for large farmers. The large farmers have enough land size for security to borrow long term loan. This helps them to purchase agricultural machines easily. Besides, the use of agricultural machinery is cost effective for the large farmers. But in the case of small and marginal farmers, those who are government employee or have dairy farm can purchase the agricultural machines. The large farmers spend more money to purchase the agricultural machines followed by the small and marginal farmers. The loan is taken mainly for agricultural activities like purchase of seeds, fertilizers, insecticides and pesticides, tractor, trolley, thrasher and other instruments.

Land preparation is the primary activity of cultivation. It is activated by each and every farmer. The cost varied according to their land holdings (Table-14). The proportion of expenditure on land preparation is almost same for each farm size.

The total expenditure incurred on seeds and crop protection measures is according to the farm size. The proportion of expenditure on local seeds is high as compared to HYV seeds during both rabi and kharif seasons (Table-15). At the farmers level, large farmers are spending more on HYV seeds and small and marginal farmers are spending more on local seeds. During the survey, it has been found that the farmers have less faith on HYV seeds. Besides HYV seeds are comparatively costly and the weather conditions are uncertain. Therefore farmers prefer local variety seeds for which they have full knowledge. The total cost on crop protection includes Farm Yard Manure (FYM), fertilizers, insecticides and pesticides. FYM and fertilizers are the nutrient feeding components to the crop and insecticides and pesticides are the crop protecting components from insects and pests. In technology based agriculture these are also the essential inputs to increase the productivity and agricultural production. In the selected regions, on all farm size categories, FYM is used once in a year. They invest more on fertilizers as compared to insecticides and pesticides in both the cropping seasons (Table-16).

The respondents are using wells and canals as the major source of irrigation (Table-17). The wells and canals are more common among small and large farmers while canals are common among marginal farmers. Farmers of Jalaun are mainly dependent on canal for irrigation. The farmers of Jhansi and Lalitpur are dependent on both canals and wells for irrigation. Very few of the farmers in Lalitpur are using nala for irrigation. As shown in table-18, in Jhansi division, out of total expenditure on irrigation, large farmers spend about 76 percent on wells followed by small (68%) and marginal (60.21%) farmers respectively. Canal irrigation is relatively cheaper. The expenditure on canal irrigation by marginal, small and large farmers is 36, 24 and 18 percent respectively. The milch animals are also the source of income for the surveyed farmers. The income as well as expenditure on milch animals is highest in Jhansi (Table-19).

The marketing expenditure (Table-20) is incurred by all the farmers for the sale of their produce. Marketing expenditure is more during rabi season as compared to kharif season. The farmers of Jhansi are spending more during rabi season as compared to Lalitpur and Jalaun district. On the other hand,

during kharif season, the farmers of Jalaun are spending more compared to Lalitpur and Jhansi district.

6.2 Ordinary Least Square and Corrected Ordinary Least Square Estimation

Table-21 shows the results of Ordinary Least Square (OLS) and Corrected Ordinary Least Square (COLS) methods obtained by processing of data with the help of Cobb – Douglas production function. To estimate the output based technical efficiency (OTE) in selected regions of different farm size categories, OLS method is the first step. With the help of this method, residual for each farmer has been calculated. The residual is the estimated deterministic production frontier. It is biased and inconsistent. Therefore, an unbiased and consistent estimate of the intercept is presented by making correction, i.e., by adding the largest positive residual of the OLS residuals. Hence, the estimates of the deterministic production frontier model are used in COLS method to find out the technical efficiency of each group of selected regions. Then, they have been ranked according to their percentage (technical efficiency). The farmer that has 100 percent technical efficiency has been considered an ideal model for others. It means the contribution of inputs applied for cultivation should not only be proper but should be followed by others. Under COLS model, the validity of the model is important rather than the significance of the individual variables. To judge or estimate the validity of model F-test is performed. If the calculated F-value is found to be greater than its table value, it should mean that the model is valid for calculation.

Table-21 also shows that the coefficient of determination varies from 0.54 to 0.93. It means that the variation in output due to variation in various inputs is explained between 54 percent to 93 percent. The calculated F-value is greater than its table value. Therefore, the model is valid for economic analysis. Statistical significance of the parameters in this estimated model is found with the help of t-values.

In the case of Jhansi district, for marginal farmers, the parameter of inputs like X_3 is positive and significant at 5 percent level of significance and X_4 and X_5 are positive and significant at 1 percent level of significance. On the contrary,

X_2 is negative and significant at 5 percent level of significance. For small farmers, the parameter of inputs like X_2, X_3 and X_4 are positive and significant at 1 percent level of significance. For large farmers the parameter of inputs like X_3 and X_4 are positive and significant at 1 percent level and X_7 at 5 percent level of significance.

In the case of Lalitpur district, for marginal farmers, the parameter of input like X_4 is significant at 5 percent level of significance and X_5 is significant at 1 percent level of significance. For small farmers, the parameter of inputs like X_3 and X_4 are positive and significant at 1 percent level of significance. X_6 is negatively and X_7 is positively significant at 10 percent level of significance. For large farmers, the parameter of inputs like X_2 is positive and significant at 5 percent level of significance.

In the case of Jalaun district, for marginal farmers, the parameter of inputs like X_1 and X_5 are positively significant at 5 percent level of significance. For small farmers, the parameter of inputs like X_2, X_3 and X_4 are positively significant at 1 percent level of significance. But, the parameter of inputs like X_1 and X_7 are positively significant at 5 percent and 10 percent level of significance respectively. Only the parameter of input like X_5 is negative and significant at 5 percent level of significance. For large farmers, the parameter of inputs like X_1, X_3 and X_4 are positive and significant at 1 percent level of significance.

For the whole Jhansi division, for marginal farmers, the parameter of inputs like X_3, X_4 and X_5 are positive and significant at 1 percent level of significance. For small farmers, the parameter of inputs like X_2, X_3 and X_4 are positive and significant at 1 percent level of significance. The parameter of inputs like X_1 and X_7 are positively significant but X_5 is negatively significant at 10 percent level of significance. For large farmers, the parameter of inputs like X_3 and X_4 are positively significant at 1 percent level of significance but X_1 is positively significant at 5 percent level of significance. This implies that investment on land preparation is effective only in Jalaun district. Investment on irrigation is not cost effective for the marginal farmers. They have small land and they have to pay for irrigation at the rate of per hour even if they extract water for less than one hour from the pumps. The miscellaneous investment like draft animal,

threshing, labour, phawada, gainthi, khurpi, hansiya are easily affordable and used by all types of farmers. The HYV seeds are cost effective as they raise the agricultural productivity. Chemical fertilizers, insecticides and pesticides are supporting agriculture for marginal farmers as their land is not optimally utilized. Their impact is found to be comparatively low for large farmers due to the utilization of land beyond its optimal capacity. Education level is very poor and it is not supporting the technical know how.

6.3 Estimating Technical Efficiency

The computation of the technical efficiency of marginal, small and large farmers of Jhansi, Lalitpur and Jalaun districts and overall is presented in table-22. The production data were ranked and the most efficient use of inputs for production was found subsequently.

The first rank farmer was considered as most efficient farmer who was using suitable quantity of inputs (i.e., according to availability and soil requirement) and producing the maximum quantity of output. In Jhansi District, among the various farm size categories, large farmer was getting maximum output, i.e., 12.995 units followed by small (12.478 units) and marginal (11.294 units) farmers. The inputs quantity used by large farmer was $X_1 = 9.518$ units, $X_2 = 9.735$ units, $X_3 = 11.112$ units, $X_4 = 9.599$ units and $X_5 = 9.457$ units $X_6 = 0.000$ units and $X_7 = 1$. In Lalitpur District, among the various farm size categories, large farmer was getting maximum output, i.e., 12.514 units followed by small (11.776 units) and marginal (11.319 units) farmers. The inputs quantity used by large farmer was $X_1 = 9.518$ units, $X_2 = 7.972$ units, $X_3 = 10.694$ units, $X_4 = 8.304$ units and $X_5 = 9.247$ units X6 = -0.511 units and $X_7 = 0$.

In Jalaun District, among the various farm size categories, large farmer was getting maximum output, i.e., 12.967 units followed by small (11.832 units) and marginal (11.359 units) farmers. The inputs quantity used by large farmer was $X_1 = 10.060$ units, $X_2 = 7.601$ units, $X_3 = 10.275$ units, $X_4 = 9.776$ units and $X_5 = 9.680$ units X6 = 0.000 units and $X_7 = 0$. In Jhansi division, among the various farm size categories, large farmer was getting maximum output, i.e., 12.664 units followed by small (12.478 units) and marginal (11.319 units) farmers. The inputs quantity used by large farmer was $X_1 = 9.596$ units, $X_2 = 9.200$ units,

$X_3 = 9.663$ units, $X_4 = 8.407$ units and $X_5 = 9.561$ units X6 = 0.000 units and $X_7 = 1$.

This show that the large size farms are more technically efficient as compared to small and marginal farm sizes. This is basically due to their cost effectiveness in using the inputs. The inputs purchased in bulk by large farmers and the optimal utilization of farm increases the productivity.

6.4 Categories of Technical Efficiency

Table-23 shows the categorization of technical efficiency of marginal, small and large farmers of Jhansi, Lalitpur and Jalaun districts with its overall region. It is revealed that among the selected regions, most of the farms are having the technical efficiency between 51 to 90 percent. The maximum number of farms are in 51 to 60 percent technical efficiency category followed by 61 to 70 percent technical efficiency category.

6.5 Test of Regional Technical Equality: Chow Test

F – Ratio is obtained to test the regional technical equality between Jhansi, Lalitpur and Jalaun districts (Table-24). F-Ratio shows, the difference between two regions for different inputs used by the marginal, small and large farmers in respective regions. If the calculated F-value is greater than its table value, then it can be interpreted that the two regions were using different quantity inputs as per the availability of time and requirement of the soil in that particular region.

In the case of Jhansi and Lalitpur districts, for marginal and small farmers and in the case of Jhansi and Jalaun districts, for marginal farmers the hypothesis is rejected and they have a significant difference for using the different amount of inputs in both the regions. But for large farmers, the hypothesis is accepted. This implies that there is no significant difference among the large farmers in using different amount of inputs in two regions. In the case of Jhansi and Jalaun districts the hypothesis is accepted for small and large farm size groups but in the case of Lalitpur and Jalaun districts, the hypothesis is accepted for all the farm size categories. This implies that there is no significant difference among the marginal-marginal, small-small and large-large farm size categories between the districts in the use of different inputs in two regions.

6.6 Input - Output Ratio

The investment may be long-term or short-term in nature. Its return can be assessed at the end of the year. Investment on fixed assets do affect the output on the farms but in combination with working capital inputs like investment in preparation of land, investment in irrigation, investment in seeds, investment in fertilizers, investment in insecticides and pesticides and labour cost and proper decision of the farmers with respect to time and quantity used of these inputs. An attempt has, therefore, been made here to examine the impact of working capital[2] (i.e., inputs) on output for the agricultural year 2009. Input-output in value terms has thus been worked out for marginal, small and large farm size categories in each selected region by dividing the working capital value from total output value and converted into percentage as shown in Table-25.

Table-25 shows that for the whole Jhansi division, marginal farmers have high input- output ratio for X_1 (5.83 percent), X_3 (16.18 percent) and X_5 (5.72 percent) and large farmers have high input-output ratio for X_2 (2.91 percent) and X_4 (5.39 percent). In Jhansi district, marginal farmers have high input-output ratio for X_3 (19.92 percent) and X_5 (5.01 percent) and large farmers have high input-output ratio for X_1 (4.19 percent), X_2 (3.86 percent) and X_4 (3.96 percent). In Lalitpur district, marginal farmers have high input-output ratio for X_1 (6.60 percent), X_3 (18.85 percent) and X_5 (6.68 percent) and large farmers have high input-output ratio for X_2 (4.64 percent) and X_4 (3.79 percent). In Jalaun district, marginal farmers have high input-output ratio for X_1 (6.87 percent), X_4 (4.84 percent) and X_5 (5.91 percent) and large farmers have high input-output ratio for X_3 (12.50 percent). Only in Jalaun district, small farmers have high input-output ratio for X_2 (0.88 percent). The overall input-output ratio is high for marginal farmers in Jhansi (34.38 percent) and Lalitpur (39.34 percent) and for small farmers in Jalaun. For the whole Jhansi division, input-output ratio is high for marginal farmers (32.91 percent) and low for small farmers (31.68 percent).

[2] Working capital here refers to the total cost incurred on inputs like investment on land preparation, irrigation, miscellaneous (draft animal, threshing, and labour, phawada, gaithi, khurpi, hansiya), seeds, FYM, and fertilizers and insecticides and pesticides.

This shows that agriculture is a costly affair for the marginal farmers and cost effective for the large farmers. The agricultural productivity for large farmers is highly related to their affordability and accessibility to cheaper inputs in bulk, irrigation, technology as well as technical knowledge and marketing.

7. Conclusion and Policy Implications

The process of development and innovations is forcing the agricultural sector to adopt new techniques of production. The technical efficiency of the agricultural sector not only depends upon the adoption of new technology but also on the various socio-economic and geographical factors and technical knowledge. The study determines the technical efficiency of each farm size and the capital output ratio in the districts of Jhansi division. It is found that the farm's cost effectiveness depends upon the farmer's affordability and accessibility to various inputs. Irrigation is cost effective for large farmers and miscellaneous investment (animal, threshing, labour, gainthi, phawada, hansiya) are cost effective for all types of farmers. The quality of land also plays an important role in determining cost effectiveness of the farm. The use of chemical inputs is cost effective for marginal farmers and not for large farmers. The large farmers have already utilized their land beyond its optimal capacity. For the marginal farmers, capacity is still available in the agricultural land for raising the output by the use of chemical inputs. Education is very poor and is found to have insignificant relation with agricultural productivity. The large farms are found to be more technical efficient followed by small and marginal farmers. Most of the farms are having technical efficiency between 51 to 90 percent. The input-output ratio is found to be high for marginal and small farmers and low for large farmers. This is due to the affordability and accessibility of large farmers to cheaper inputs, irrigation, technical knowledge and marketing. This shows that practicing agriculture is a costly affair for marginal farmers as compared to small and large farmers.

The Chow test has shown that there is no significant difference among the marginal-marginal, small-small and large-large farm size categories between the districts for the use of different inputs between two regions.

All the farmers are investing about one third of previous year's output value

during the current year. The total output for marginal farmers is found to be elastic with respect to farm yard manure, fertilizers and insecticides and pesticides while for the small and large farmers, it is negative and insignificant. This indicates the over utilization of land by small and large farmers with the use of excess chemical inputs that is now giving diminishing returns.

The following suggestions are put forth:

1. In order to increase the technical efficiency of the marginal farms, there is a need to practice joint farming system. This would reduce the cost of production especially in terms of irrigation, land preparation and purchase of inputs.
2. Infrastructural facilities for agriculture and irrigation should be developed at village level to boost up the agricultural production. Focus should be on creating strong base for agriculture. This includes irrigation, rural roads, power, market and cold storage.
3. Awareness should be generated for the balanced use of inputs in the agricultural farm. This, on the one hand would decrease the capital-output ratio and increase the farm efficiency and on the other hand, the increased agriculture productivity would check distress migration.
4. For the poor farmers, the credit policy should be made easy and flexible.

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Table-1. A Glance at Jhansi Division in Uttar Pradesh

S.No	Details	1991		2001	
		Jhansi Division	Uttar Pradesh	Jhansi Division	Uttar Pradesh
1	Total Population (in 000)	3401.12	139112.3	4177.1	166197.9
2	Density	233	548	287	689
3	Sex Ratio	852	876	867	898
4	Literacy Rate	44.94	40.71	60.92	57.36
5	Female Literacy Rate	27.39	24.37	45.04	42.98
6	Social Backwardness (Percentage to Total Population)	29.5	21.88	29.2	21.21
7	Percentage of Total workers to total population	31	29.73	27	32.6
8	Rural Work Participation Rate	32.2	-	27.8	-
9	Urban Work Participation Rate	26.5	-	23.9	-
10	Percentage of Cultivators to total workers	60.1	53.27	52.8	40.9
11	Percentage of agricultural laborers to total workers	18.2	18.94	12.5	25.1

Sources: (1) http://censusindia.gov.in/Tables_Publish
(2) http://planningup.nic.in/dev_ind/devind_body.htm

Table-2. Occupational Classification of Respondent's Family

Districts	Farm Size Categories	Number of Persons in Farm Sector	Number of Persons in Non–Farm Sector	Dependents
Jhansi	Marginal	101 (42.26)	50 (20.92)	88 (36.82)
	Small	101 (37.55)	57 (21.19)	111 (41.26)
	Large	78 (35.14)	56 (25.23)	88 (39.64)
Lalitpur	Marginal	58 (25.00)	62 (26.72)	112 (48.28)
	Small	76 (29.46)	81 (31.40)	101 (39.15)
	Large	75 (31.78)	76 (32.20)	85 (36.02)
Jalaun	Marginal	59 (27.44)	65 (30.23)	91 (42.33)
	Small	53 (22.65)	75 (32.05)	106 (45.30)
	Large	68 (26.98)	67 (26.59)	117 (46.43)
Jhansi Division	Marginal	218 (31.78)	177 (25.80)	291 (42.42)
	Small	230 (30.22)	213 (27.99)	318 (41.79)
	Large	221 (31.13)	199 (28.03)	710 (40.85)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage

Table-3. Respondent's Family Income

Districts	Farm Size Categories	Income from Different Sources (In 000, Rs.)				
		Agriculture	Animals	Govt. Services	Other Sources	Total
Jhansi	Marginal	3360.38 (43.31)	1015.50 (13.09)	3004.00 (38.72)	378.60 (4.88)	7758.48 (100.00)
	Small	8142.59 (79.02)	1096.00 (10.64)	802.00 (7.78)	263.40 (2.56)	10303.99 (100.00)
	Large	15372.55 (80.89)	1495.00 (7.87)	1748.40 (9.20)	389.00 (2.05)	19004.95 (100.00)
Lalitpur	Marginal	1924.14 (52.07)	534.70 (14.47)	1057.20 (28.61)	179.00 (4.84)	3695.04 (100.00)
	Small	6339.94 (67.80)	1157.50 (12.38)	1478.00 (15.81)	376.00 (4.02)	9351.44 (100.00)
	Large	15548.41 (72.37)	2561.50 (11.92)	2705.00 (12.59)	669.00 (3.11)	21483.91 (100.00)
Jalaun	Marginal	1895.46 (37.46)	1884.00 (37.24)	1098.00 (21.70)	182.00 (3.60)	5059.46 (100.00)
	Small	6798.66 (52.13)	3409.00 (26.14)	2636.00 (20.21)	199.00 (1.53)	13042.66 (100.00)
	Large	19547.01 (73.36)	3860.00 (14.49)	3204.00 (12.02)	36.00 (0.14)	26647.01 (100.00)
Jhansi Division	Marginal	7179.98 (43.48)	3434.20 (20.80)	5159.20 (31.24)	739.60 (4.48)	16512.98 (100.00)
	Small	21281.19 (65.08)	5662.50 (17.32)	4916.00 (15.03)	838.40 (2.56)	32698.09 (100.00)
	Large	50467.96 (75.17)	7916.50 (11.79)	7657.40 (11.41)	1094.00 (1.63)	67135.86 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-4. Educational Level of Respondent's Family

Districts	Farm Size Categories	Educational Level				
		Nil	Up to Primary	Up to Secondary	Above Secondary	Total
Jhansi	Marginal	68 (28.45)	112 (46.86)	33 (13.81)	26 (10.88)	(100.00)
	Small	49 (18.22)	108 (40.15)	44 (16.36)	68 (25.28)	269 (100.00)
	Large	31 (13.96)	85 (38.29)	43 (19.37)	63 (28.38)	222 (100.00)
Lalitpur	Marginal	74 (31.90)	110 (47.41)	33 (14.22)	15 (6.47)	232 (100.00)
	Small	87 (33.72)	115 (44.57)	42 (16.28)	14 (5.43)	258 (100.00)
	Large	59 (25.00)	69 (29.24)	58 (24.58)	50 (21.19)	236 (100.00)
Jalaun	Marginal	34 (15.81)	83 (38.60)	59 (27.44)	39 (18.14)	215 (100.00)
	Small	20 (8.55)	70 (29.91)	61 (26.07)	83 (35.47)	234 (100.00)
	Large	42 (16.67)	73 (28.97)	42 (16.67)	95 (37.70)	252 (100.00)
Jhansi Division	Marginal	176 (25.66)	305 (44.46)	125 (18.22)	80 (11.66)	686 (100.00)
	Small	156 (20.50)	293 (38.50)	147 (19.32)	165 (21.68)	761 (100.00)
	Large	132 (18.59)	227 (31.97)	143 (20.14)	208 (29.30)	710 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-5. Land Use under Different Crops in Rabi Season

Districts	Farm Size Categories	Area Under Different Crops (In Acres)							
		Wheat	Gram	Peas	Masoor	Rapeseed-Mustard	Vegetable	Fallow Land	Total Area
Jhansi	Marginal	49.15 (56.24)	21.8 (24.94)	10.5 (12.01)	0 (0.00)	4.75 (5.43)	1.2 (1.37)	0 (0.00)	87.4 (100.00)
	Small	100 (49.14)	59 (28.99)	31.22 (15.34)	0 (0.00)	8.75 (4.30)	1.18 (0.58)	3.37 (1.66)	203.52 (100.00)
	Large	211.5 (44.86)	112.75 (23.91)	68.5 (14.53)	4 (0.85)	21.5 (4.56)	5.5 (1.17)	47.75 (10.13)	471.5 (100.00)
Lalitpur	Marginal	65.17 (89.16)	4.57 (6.25)	2 (2.74)	0 (0.00)	0.1 (0.14)	1.25 (1.71)	0 (0.00)	73.09 (100.00)
	Small	110.23 (54.99)	46.95 (23.42)	25.65 (12.80)	4 (2.00)	3.85 (1.92)	4.18 (2.09)	5.58 (2.78)	200.44 (100.00)
	Large	378.88 (70.35)	91.5 (16.99)	46 (8.54)	0 (0.00)	2.5 (0.46)	9 (1.67)	10.68 (1.98)	538.56 (100.00)
Jalaun	Marginal	51.55 (55.73)	26.4 (28.54)	7.15 (7.73)	2.5 (2.70)	2.5 (2.70)	0.45 (0.49)	1.95 (2.11)	92.5 (100.00)
	Small	101 (52.06)	38.5 (19.85)	29 (14.95)	16 (8.25)	9.5 (4.90)	0 (0.00)	0 (0.00)	194 (100.00)
	Large	242 (39.10)	97.5 (15.75)	73.5 (11.87)	69 (11.15)	28.5 (4.60)	0 (0.00)	108.5 (17.53)	619 (100.00)
Jhansi Division	Marginal	165.87 (65.56)	52.77 (20.86)	19.65 (7.77)	2.5 (0.99)	7.35 (2.91)	2.9 (1.15)	1.95 (0.77)	252.99 (100.00)
	Small	311.23 (52.05)	144.45 (24.16)	85.87 (14.36)	20 (3.34)	22.1 (3.70)	5.36 (0.90)	8.95 (1.50)	597.96 (100.00)
	Large	832.38 (51.10)	301.75 (18.52)	188 (11.54)	73 (4.48)	52.5 (3.22)	14.5 (0.89)	166.93 (10.25)	1629.06 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-6. Total Production of Different Crops in Rabi Season

Districts	Farm Size Categories	Total Production of Different Crops (In Quintals)				
		Wheat	Gram	Peas	Masoor	Rapeseed-Mustard
Jhansi	Marginal	635.50	180.00	88.50	0.00	28.50
	Small	1229.00	475.50	237.50	0.00	79.45
	Large	2685.50	812.75	465.00	36.00	65.50
Lalitpur	Marginal	771.50	33.50	15.00	0.00	0.40
	Small	1218.00	322.00	170.00	27.00	18.50
	Large	4336.00	558.00	293.50	0.00	8.00
Jalaun	Marginal	722.00	213.50	58.50	11.50	10.00
	Small	1562.00	315.50	220.00	79.50	39.50
	Large	3419.00	733.75	545.00	458.10	83.00
Jhansi Division	Marginal	2129.00	427.00	162.00	11.50	38.90
	Small	4009.00	1113.00	627.50	106.50	137.45
	Large	10440.50	2104.50	1303.50	494.10	156.50

Source: Primary Survey (2008-09).

Table-7. Land Use under Different Crops in Kharif Season

Districts	Farm Size Categories	Area Under Different Crops (In Acres)									
		Maize	Urad	Moong	Arhar	Bazra	Ground-nut	Sugarcane	Vegetables	Fallow Land	Total Area
Jhansi	Marginal	17.66 (20.21)	23.58 (26.98)	18.85 (21.57)	0.00 (0.00)	0.00 (0.00)	24.61 (28.16)	0.00 (0.00)	2.45 (2.80)	0.25 (0.29)	87.40 (100.00)
	Small	20.68 (10.16)	52.25 (27.15)	47.25 (23.22)	0.00 (0.00)	0.00 (0.00)	71.50 (35.13)	0.00 (0.00)	1.68 (0.83)	7.16 (3.52)	203.52 (100.00)
	Large	55.00 (11.66)	90.50 (19.19)	68.00 (14.42)	0.00 (0.00)	4.00 (0.85)	219.00 (46.45)	0.00 (0.00)	8.50 (1.80)	26.50 (5.62)	471.50 (100.00)
Lalitpur	Marginal	42.59 (58.27)	15.85 (21.69)	7.69 (10.52)	0.00 (0.00)	0.00 (0.00)	5.00 (6.84)	0.00 (0.00)	1.75 (2.39)	0.48 (0.66)	73.09 (100.00)
	Small	57.85 (28.86)	63.75 (31.81)	36.00 (17.96)	0.00 (0.00)	0.00 (0.00)	30.50 (15.22)	0.00 (0.00)	4.18 (2.09)	8.16 (4.07)	200.44 (100.00)
	Large	149.50 (27.76)	156.50 (29.06)	109.00 (20.24)	0.00 (0.00)	0.00 (0.00)	56.00 (10.40)	0.00 (0.00)	16.00 (2.97)	51.56 (9.57)	538.56 (100.00)
Jalaun	Marginal	7.75 (8.38)	41.40 (44.76)	28.45 (30.76)	9.75 (10.54)	1.75 (1.89)	1.50 (1.62)	1.45 (1.57)	0.45 (0.49)	0.00 (0.00)	92.50 (100.00)
	Small	15.50 (7.99)	55.00 (28.35)	5.00 (25.77)	31.00 (15.98)	17.50 (9.02)	0.00 (0.00)	24.00 (12.37)	0.00 (0.00)	1.00 (0.52)	194.00 (100.00)
	Large	18.00 (2.91)	175.00 (28.27)	152.50 (24.64)	117.00 (18.90)	35.50 (5.74)	2.00 (0.32)	81.50 (13.17)	0.00 (0.00)	37.50 (6.06)	619.00 (100.00)
Jhansi Division	Marginal	68.00 (26.88)	80.83 (31.95)	54.99 (21.74)	9.75 (3.85)	1.75 (0.69)	31.11 (12.30)	1.45 (0.57)	4.65 (1.84)	0.73 (0.29)	252.99 (100.00)
	Small	94.03 (15.73)	174.00 (29.10)	133.25 (22.28)	31.00 (5.18)	17.50 (2.93)	102.00 (17.06)	24.00 (4.01)	5.86 (0.98)	16.32 (2.73)	597.96 (100.00)
	Large	222.50 (13.66)	422.00 (25.90)	329.50 (20.23)	117.00 (7.18)	39.50 (2.42)	277.00 (17.00)	81.50 (5.00)	24.50 (1.50)	115.56 (7.09)	1629.06 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-8. Total Production of Different Crops in Kharif Season

Districts	Farm Size Categories	Total Production of Different Crops (In Quintals)							
		Wheat	Urad	Moong	Arhar	Bazra	Groundnut	Sugarcane	Vegetables
Jhansi	Marginal	165.5	184.5	138	0	0	258	0	NA
	Small	175.5	447	344	0	0	810	0	NA
	Large	400.5	636	440.5	0	24	1959.5	0	NA
Lalitpur	Marginal	303.75	105	44.5	0	0	46	0	NA
	Small	417.5	402	231.5	0	0	297	0	NA
	Large	646	968	637.5	0	0	459	0	NA
Jalaun	Marginal	71	324.5	220	31	13.5	10	145	NA
	Small	119	433.5	388.5	97	104	0	2400	NA
	Large	107	1299.75	1132.25	371	242	16	8150	NA
Jhansi Division	Marginal	540.25	614	402.5	31	13.5	314	145	NA
	Small	712	1282.5	964	97	104	1107	2400	NA
	Large	1153.5	2903.75	2210.25	371	266	2434.5	8150	NA

Source: Primary Survey (2008-09).

Table-9. Total Annual Agricultural Expediture and Income of the Farmers (Rs. '000 / per acre of cultivated area)

Districts	Farm Size Categories	Total Annual Agricultural Cost and Income per acre of cultivated area	
		Expenditure (Rs. '000)	Income (Rs. '000)
Jhansi	Marginal	13.22	38.45
	Small	11.62	40.01
	Large	9.95	32.60
Lalitpur	Marginal	10.36	26.33
	Small	10.78	31.63
	Large	10.36	28.87
Jalaun	Marginal	10.17	36.60
	Small	11.43	35.04
	Large	9.38	31.58
Jhansi Division	Marginal	11.28	34.27
	Small	11.28	35.59
	Large	9.87	30.98

Source: Primary Survey (2008-09).

Table-10. Total Number and Expenditure on Draft Animals

Districts	Farm Size Categories	Total Numbers of Bullocks (per 100 acre)	Total Expenditure on Bullocks (Rs. '000/per 100 acre)
Jhansi	Marginal	42.33	236.27
	Small	17.69	85.99
	Large	2.97	14.21
Lalitpur	Marginal	38.31	175.13
	Small	33.43	150.67
	Large	9.10	50.88
Jalaun	Marginal	0.00	0.00
	Small	0.00	0.00
	Large	0.00	0.00
Jhansi Division	Marginal	25.69	132.22
	Small	17.23	79.77
	Large	3.87	20.93

Source: Primary Survey (2008-09).

Table-11. Total Expenditure on Animal Driven Implements

Districts	Farm Size Categories	Expenditure on Animal Driven Agricultural Instrumets (In 000, Rs.)					
		Wooden Plough	Iron Ploug	Wooden Seed Drill	Bullock Cart	Wooden Soil Leveler	Total Expenditure
Jhansi	Marginal	15.00 (53.48)	0.00 (0.00)	0.00 (0.00)	11.10 (39.57)	1.95 (6.95)	28.05 (100.00)
	Small	11.95 (32.56)	2.80 (7.63)	0.00 (0.00)	18.70 (50.95)	3.25 (8.86)	36.70 (100.00)
	Large	2.00 (20.62)	0.00 (0.00)	0.00 (0.00)	7.00 (72.16)	0.70 (7.22)	9.70 (100.00)
Lalitpur	Marginal	9.90 (72.53)	0.00 (0.00)	0.00 (0.00)	3.00 (21.98)	0.75 (5.49)	13.65 (100.00)
	Small	39.95 (55.91)	0.00 (0.00)	0.00 (0.00)	25.10 (35.13)	6.40 (8.96)	71.45 (100.00)
	Large	11.40 (66.67)	0.00 (0.00)	0.00 (0.00)	4.00 (23.39)	1.70 (9.94)	17.10 (100.00)
Jalaun	Marginal	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (100.00)
	Small	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (100.00)
	Large	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (100.00)
Jhansi Division	Marginal	24.90 (59.71)	0.00 (0.00)	0.00 (0.00)	14.10 (33.81)	2.70 (6.47)	41.70 (100.00)
	Small	51.90 (47.99)	2.80 (2.59)	0.00 (0.00)	43.80 (40.50)	9.65 (8.92)	108.15 (100.00)
	Large	13.40 (50.00)	0.00 (0.00)	0.00 (0.00)	11.00 (41.04)	2.40 (8.96)	26.80 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-12. Total Expenditure on Human Driven Implements

Districts	Farm Size Categories	Expenditure on Human Driven Agricultural Instrumets (In 000, Rs.)						
		Khurpi	Phawada	Gaithi	Wooden Pachcha	Iron	Hansiya	Total Expenditure
Jhansi	Marginal	2.20 (17.08)	2.36 (18.36)	2.26 (17.58)	3.88 (30.14)	1.10 (8.56)	1.07 (8.28)	12.86 (100.00)
	Small	1.87 (12.34)	2.78 (18.40)	1.90 (12.57)	4.10 (27.13)	3.20 (21.18)	1.27 (8.37)	15.11 (100.00)
	Large	2.17 (9.40)	4.00 (17.31)	2.36 (10.23)	6.21 (26.89)	6.80 (29.47)	1.55 (6.70)	23.08 (100.00)
Lalitpur	Marginal	1.61 (16.88)	2.47 (25.98)	1.71 (17.98)	2.48 (26.08)	0.00 (0.00)	1.24 (13.07)	9.51 (100.00)
	Small	2.53 (12.22)	3.68 (17.75)	2.98 (14.39)	7.41 (35.79)	2.60 (12.56)	1.51 (7.29)	20.71 (100.00)
	Large	3.84 (9.85)	5.10 (13.08)	2.88 (7.39)	9.15 (23.46)	15.80 (40.52)	2.23 (5.71)	39.00 (100.00)
Jalaun	Marginal	1.66 (8.12)	3.47 (16.95)	0.99 (4.84)	7.44 (36.39)	5.30 (25.92)	1.59 (7.78)	20.45 (100.00)
	Small	1.05 (3.82)	3.40 (12.33)	2.67 (9.68)	10.10 (36.63)	8.70 (31.55)	1.65 (5.98)	27.57 (100.00)
	Large	3.75 (5.93)	6.15 (9.73)	3.79 (6.00)	11.92 (18.86)	35.25 (55.78)	2.33 (3.69)	63.19 (100.00)
Jhansi Division	Marginal	5.46 (12.75)	8.30 (19.38)	4.96 (11.59)	13.80 (32.23)	6.40 (14.95)	3.90 (9.11)	42.81 (100.00)
	Small	5.45 (8.59)	9.86 (15.55)	7.55 (11.91)	21.61 (34.09)	14.50 (22.87)	4.43 (6.98)	63.39 (100.00)
	Large	9.76 (7.79)	15.25 (12.17)	9.03 (7.21)	27.28 (21.77)	57.85 (46.18)	6.10 (4.87)	125.26 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-13. Total Expenditure on Own Agricultural Machines

Districts	Farm Size Categories	Expenditure on Agricultural Machine Power Instruments (In 000, Rs.)						
		Tractor	Thresher	Seed Drill And Plough	Diesel Pump	Electric	Irrigation	Total Expenditure
Jhansi	Marginal	1775.00 (79.66)	58.50 (2.63)	72.00 (3.23)	291.00 (13.06)	0.00 (0.00)	31.60 (1.42)	2228.10 (100.00)
	Small	2425.00 (75.46)	206.00 (6.41)	135.00 (4.20)	402.70 (12.53)	0.00 (0.00)	45.10 (1.40)	3213.80 (100.00)
	Large	4130.00 (76.24)	377.00 (6.96)	248.00 (4.58)	572.10 (10.56)	0.00 (0.00)	89.70 (1.66)	5416.80 (100.00)
Lalitpur	Marginal	350.00 (64.29)	0.00 (0.00)	25.00 (4.59)	163.00 (29.94)	0.00 (0.00)	6.40 (1.18)	544.40 (100.00)
	Small	700.00 (65.97)	85.00 (8.01)	55.00 (5.18)	201.90 (19.03)	0.00 (0.00)	19.20 (1.81)	1061.10 (100.00)
	Large	4681.00 (73.88)	450.00 (7.10)	321.00 (5.07)	816.20 (12.88)	0.00 (0.00)	67.50 (1.07)	6335.70 (100.00)
Jalaun	Marginal	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (100.00)
	Small	3225.00 (84.60)	328.00 (8.60)	259.00 (6.79)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	3812.00 (100.00)
	Large	4250.00 (83.18)	398.00 (7.79)	303.00 (5.93)	158.70 (3.11)	0.00 (0.00)	0.00 (0.00)	5109.70 (100.00)
Jhansi Division	Marginal	2125.00 (76.65)	58.50 (2.11)	97.00 (3.5)	454.00 (16.38)	0.00 (0.00)	38.00 (1.37)	2772.50 (100.00)
	Small	6350.00 (78.52)	619.00 (7.65)	449.00 (5.55)	604.60 (7.48)	0.00 (0.00)	64.30 (0.80)	8086.90 (100.00)
	Large	13061.00 (77.46)	1225.00 (7.26)	872.00 (5.17)	1547.00 (9.17)	0.00 (0.00)	157.20 (0.93)	16862.20 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-14.Total Expenditure on Land Preparation for Cultivation

Districts	Farm Size Categories	Total Expenditure on Land Preparation (In 000, Rs.)		
		Rabi Season	Kharif Season	Total Cost
Jhansi	Marginal	88.14 (66.44)	44.52 (33.56)	132.66 (100.00)
	Small	213.05 (66.80)	105.89 (33.20)	318.94 (100.00)
	Large	666.90 (75.08)	221.30 (24.92)	888.20 (100.00)
Lalitpur	Marginal	82.26 (64.77)	44.74 (35.23)	127.00 (100.00)
	Small	243.15 (67.52)	116.95 (32.48)	360.10 (100.00)
	Large	646.85 (67.10)	317.310 (32.90)	963.95 (100.00)
Jalaun	Marginal	164.34 (66.83)	81.57 (33.17)	245.91 (100.00)
	Small	311.40 (66.67)	155.70 (33.33)	467.10 (100.00)
	Large	766.70 (63.70)	437.00 (36.30)	1203.70 (100.00)
Jhansi Division	Marginal	334.74 (66.21)	170.82 (33.79)	505.57 (100.00)
	Small	767.60 (66.97)	378.54 (33.03)	1146.14 (100.00)
	Large	2080.45 (68.08)	675.40 (31.92)	3055.85 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-15. Total Expenditure on Seeds

Districts	Farm Size Categories	Total Expenditure on seeds (In 000, Rs.)				
		Rabi Season		Kharif Season		Total Cost
		HYV Seeds	Local Seeds	HYV Seeds	Local Seeds	
Jhansi	Marginal	17.42 (20.06)	33.92 (39.08)	13.50 (15.55)	21.96 (25.30)	86.76 (100.00)
	Small	34.10 (14.55)	98.61 (42.08)	52.31 (22.32)	49.34 (21.05)	234.36 (100.00)
	Large	113.83 (18.71)	163.59 (26.89)	274.40 (45.10)	56.55 (9.30)	608.37 (100.00)
Lalitpur	Marginal	5.05 (9.53)	28.41 (53.59)	2.53 (4.76)	17.03 (32.12)	53.01 (100.00)
	Small	40.52 (18.78)	98.96 (45.87)	36.18 (16.77)	40.07 (18.58)	215.73 (100.00)
	Large	250.65 (42.52)	154.59 (26.23)	90.75 (15.40)	93.46 (15.86)	589.45 (100.00)
Jalaun	Marginal	23.20 (23.66)	43.28 (44.14)	6.74 (6.87)	24.84 (25.33)	98.05 (100.00)
	Small	96.55 (29.37)	81.00 (24.64)	34.13 (10.38)	117.07 (35.61)	328.75 (100.00)
	Large	253.60 (27.27)	175.91 (18.91)	132.40 (14.23)	368.20 (39.59)	930.11 (100.00)
Jhansi Division	Marginal	45.67 (19.20)	105.61 (44.40)	22.77 (9.57)	63.82 (26.83)	237.86 (100.00)
	Small	171.17 (21.98)	278.57 (35.77)	122.61 (15.74)	206.48 (26.51)	778.83 (100.00)
	Large	618.08 (29.05)	494.09 (23.22)	497.55 (23.38)	518.21 (24.35)	2127.92 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-16. Total Expenditure on Crop Protection Measures

Districts	Farm Size Categories	Total Expenditure on Crop Protection (In 000, Rs.)						
		Rabi Season			Kharif Season			Total Inputs Cost
		FYM	Fertilizers	Insecticides and Pesticides	FYM	Fertilizers	Insecticides and Pesticides	
Jhansi	Marginal	15.05 (8.89)	80.95 (47.79)	16.45 (9.71)	0.00 (0.00)	41.90 (24.74)	15.03 (8.87)	169.38 (100.00)
	Small	14.80 (4.80)	145.80 (47.32)	32.00 (10.39)	0.00 (0.00)	62.50 (20.29)	53.00 (17.20)	308.10 (100.00)
	Large	33.05 (5.26)	317.25 (50.53)	44.25 (7.05)	0.00 (0.00)	147.25 (23.45)	86.05 (13.71)	627.85 (100.00)
Lalitpur	Marginal	15.10 (11.74)	72.85 (56.64)	5.65 (4.39)	0.00 (0.00)	25.08 (19.49)	9.95 (7.74)	128.63 (100.00)
	Small	24.90 (7.44)	166.25 (49.70)	25.60 (7.65)	0.00 (0.00)	81.10 (24.25)	36.65 (10.96)	334.50 (100.00)
	Large	82.15 (8.07)	523.43 (51.44)	141.98 (13.95)	0.00 (0.00)	182.33 (17.92)	87.60 (8.61)	1017.48 (100.00)
Jalaun	Marginal	27.00 (13.60)	88.25 (44.45)	13.30 (6.70)	0.00 (0.00)	45.50 (22.92)	24.50 (12.34)	198.55 (100.00)
	Small	37.00 (9.22)	193.50 (48.19)	28.75 (7.16)	0.00 (0.00)	99.00 (24.66)	43.25 (10.77)	401.50 (100.00)
	Large	82.70 (7.69)	512.50 (47.65)	82.75 (7.69)	0.00 (0.00)	257.75 (24.89)	129.88 (12.07)	1075.58 (100.00)
Jhansi Division	Marginal	57.15 (11.51)	242.05 (48.75)	35.40 (7.13)	0.00 (0.00)	112.48 (22.65)	49.48 (9.96)	496.55 (100.00)
	Small	76.70 (7.35)	505.55 (48.42)	86.35 (8.27)	0.00 (0.00)	242.60 (23.24)	132.90 (12.73)	1044.10 (100.00)
	Large	197.90 (7.27)	1353.18 (49.73)	268.98 (9.89)	0.00 (0.00)	597.33 (21.95)	303.53 (11.16)	2720.90 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-17.Total Number of Irrigation from Different Sources

Districts	Farm Size Categories	Total Number of Irrigation from Different Sources					
		Canal	Well	Nala	River	Local Pond	Nal Koop
Jhansi	Marginal	27	122	0	0	4	0
	Small	19	126	0	0	5	0
	Large	37	103	0	0	10	0
Lalitpur	Marginal	76	48	19	0	7	0
	Small	23	112	9	0	6	0
	Large	11	125	14	0	0	0
Jalaun	Marginal	150	0	0	0	0	0
	Small	150	0	0	0	0	0
	Large	148	2	0	0	0	0
Jhansi Division	Marginal	253	170	19	0	11	0
	Small	192	238	9	0	11	0
	Large	196	230	14	0	10	0

Source: Primary Survey (2008-09).

Table-18. Total Expenditure on Different Sources of Irrigation

Districts	Farm Size Categories	Expenditure on Different Irrigational Sources (In 000, Rs.)						
		Canal	Well	Nala	River	Local Pond	Nal Kopp	Total Cost
Jhansi	Marginal	6.45 (6.58)	88.10 (89.94)	0.00 (0.00)	0.00 (0.00)	3.40 (3.47)	0.00 (0.00)	97.75 (100.00)
	Small	16.13 (9.29)	148.54 (85.54)	0.00 (0.00)	0.00 (0.00)	8.98 (5.17)	0.00 (0.00)	173.64 (100.00)
	Large	91.30 (15.40)	468.75 (79.08)	0.00 (0.00)	0.00 (0.00)	32.73 (5.52)	0.00 (0.00)	592.78 (100.00)
Lalitpur	Marginal	27.75 (32.46)	39.05 (45.68)	14.75 (17.25)	0.00 (0.00)	3.94 (4.61)	0.00 (0.00)	85.48 (100.00)
	Small	32.48 (14.70)	161.33 (73.03)	17.83 (8.07)	0.00 (0.00)	9.29 (4.20)	0.00 (0.00)	220.91 (100.00)
	Large	33.95 (4.71)	631.72 (87.60)	55.50 (7.70)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	721.17 (100.00)
Jalaun	Marginal	27.75 (100.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	59.93 (100.00)
	Small	59.93 (100.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	59.93 (100.00)
	Large	145.75 (93.64)	9.90 (6.36)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	155.65 (100.00)
Jhansi Division	Marginal	61.95 (29.33)	127.15 (60.21)	14.75 (6.98)	0.00 (0.00)	7.34 (3.48)	0.00 (0.00)	211.18 (100.00)
	Small	108.53 (23.88)	309.86 (68.18)	17.83 (3.92)	0.00 (0.00)	18.26 (4.02)	0.00 (0.00)	454.47 (100.00)
	Large	271.00 (18.44)	1110.37 (75.56)	55.50 (3.78)	0.00 (0.00)	32.73 (2.23)	0.00 (0.00)	1469.60 (100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-19. Total Number, Expenditure and Income from Milch Animals

Districts	Farm Size Categories	Total Number of Milch Animals				Total Yearly Expenditure (In 000, Rs.)	Total Yearly Income (In 000, Rs.)
		Cows	Buffalos	Goats	Sheeps		
Jhansi	Marginal	63	48	49	0	675.50	1015.50
	Small	71	40	24	80	607.00	1096.00
	Large	56	78	5	0	808.50	1495.00
Lalitpur	Marginal	81	22	15	0	474.00	534.70
	Small	82	64	17	0	731.00	1157.50
	Large	101	162	48	0	1642.00	2561.50
Jalaun	Marginal	57	65	0	0	857.00	1884.00
	Small	85	119	0	0	1384.00	3409.00
	Large	88	123	0	0	1541.00	3860.00
Jhansi Division	Marginal	201	135	64	0	2006.50	3434.20
	Small	238	223	41	80	2722.00	5662.50
	Large	245	363	53	0	3991.50	7916.50

Source: Primary Survey (2008-09).

Table-20.Total Marketing Expenditure

Districts	Farm Size Categories	Total Marketing Expenditure (In 000, Rs.)		
		Rabi Season	Kharif Season	Total Cost
Jhansi	Marginal	44.22	23.50	67.72
		(65.30)	(34.70)	(100.00)
	Small	80.80	44.45	125.25
		(64.51)	(35.49)	(100.00)
	Large	143.30	104.50	247.80
		(57.83)	(42.17)	(100.00)
Lalitpur	Marginal	40.25	29.75	70.00
		(57.50)	(42.50)	(100.00)
	Small	91.05	73.60	164.65
		(55.30)	(44.70)	(100.00)
	Large	210.90	149.60	360.50
		(58.50)	(41.50)	(100.00)
Jalaun	Marginal	69.90	59.90	129.80
		(53.85)	(46.15)	(100.00)
	Small	115.60	95.50	211.10
		(54.76)	(45.24)	(100.00)
	Large	319.35	289.25	608.60
		(52.47)	(47.53)	(100.00)
Jhansi Division	Marginal	154.37	113.15	267.52
		(57.70)	(42.30)	(100.00)
	Small	287.45	213.55	501.00
		(57.38)	(42.62)	(100.00)
	Large	673.55	543.35	1216.90
		(55.35)	(44.65)	(100.00)

Source: Primary Survey (2008-09). Figure in parenthesis () shows percentage.

Table-21. Ordinary Least Square (OLS) and Corrected Ordinary Least Square (COLS Estimation)

Dist.	Farm Size	Equ. form	Variables								R^2	F-value
			Intercept	X_{1i}	X_{2i}	X_{3i}	X_{4i}	X_{5i}	X_{6i}	X_{7i}		
Jhansi District	Marginal	OLS	5.951	-0.027 (0.46)	-0.12** (2.27)	0.088** (2.43)	0.333* (4.75)	0.361*(3.57)	-0.038(0.67)	0.015(0.316)	0.905	56.84
		COLS	5.951+0.303	-0.027 (0.46)	-0.116 (2.269)	0.088 (2.427)	0.333 (4.748)	0.361 (3.573)	-0.038 (0.67)	0.015 (0.316)	0.905	56.84
	Small	OLS	4.921	0.026 (0.41)	0.124* (3.99)	0.370* (6.77)	0.252* (4.99)	-0.001(0.01)	0.079(0.97)	0.062 (1.231)	0.723	15.64
		COLS	4.921+0.475	0.026 (0.41)	0.124 (3.991)	0.370 (6.774)	0.252 (4.990)	-0.001(0.010)	0.079 (0.97)	0.062 (1.231)	0.723	15.64
	Large	OLS	5.394	0.038 (0.56)	0.001 (0.04)	0.193* (4.50)	0.346* (4.23)	0.160 (1.49)	0.005(0.08)	0.074*** (1.85)	0.923	72.27
		COLS	5.394+0.177	0.038 (0.56)	0.001 (0.039)	0.193 (4.504)	0.346 (4.230)	0.160 (1.491)	0.005 (0.08)	0.074 (1.849)	0.923	72.27
Lalitpur District	Marginal	OLS	3.648	-0.069 (0.61)	0.013 (0.16)	0.072 (1.28)	0.420* (2.52)	0.490* (3.15)	0.085 (0.65)	-0.106 (0.839)	0.814	26.18
		COLS	3.648+ .597	-0.069 (0.61)	0.013 (0.155)	0.072 (1.276)	0.420 (2.515)	0.490 (3.150)	0.085 (0.65)	-0.106 (0.839)	0.814	26.18
	Small	OLS	4.453	0.014 (0.13)	0.055 (0.63)	0.319* (3.29)	0.480* (4.25)	-0.064 (0.32)	-.15*** (1.67)	0.134*** (1.62)	0.541	7.06
		COLS	4.453+ .387	0.014 (0.13)	0.055 (0.629)	0.319 (3.287)	0.480 (4.245)	-0.064 (0.318)	-0.149(1.67)	0.134 (1.622)	0.541	7.06
	Large	OLS	4.238	0.250 (1.28)	0.324** (2.19)	0.141 (1.56)	0.189 (1.43)	-0.021 (0.12)	0.176 (0.79)	-0.213 (1.06)	0.638	10.55
		COLS	4.238+ .502	0.250 (1.28)	0.324 (2.194)	0.141 (1.556)	0.189 (1.427)	-0.021 (0.121)	0.176 (0.79)	-0.213(1.058)	0.638	10.55
Jalaun District	Marginal	OLS	4.003	0.576* (2.03)	-0.060 (0.61)	0.079 (0.84)	0.152** (2.06)	0.091 (0.65)	0.027 (0.20)	NA	0.781	25.57
		COLS	4.003+ .289	0.576 (2.03)	-0.060 (0.614)	0.079 (0.844)	0.152 (2.062)	0.091(0.649)	0.027 (0.20)	NA	0.781	25.57
	Small	OLS	4.977	0.522** (2.33)	0.360* (2.84)	0.353* (4.24)	0.221* (4.35)	-0.66** (2.11)	0.150(1.35)	0.234***(1.78)	0.787	22.17
		COLS	4.977+ .202	0.522 (2.33)	0.360 (2.840)	0.353 (4.238)	0.221 (4.349)	-0.657 (2.114)	0.150 (1.35)	0.234 (1.778)	0.787	22.17
	Large	OLS	3.430	0.519* (3.27)	0.039 (0.80)	0.253* (3.14)	0.222* (3.08)	-0.105 (0.54)	-0.033 (0.36)	0.142 (1.43)	0.931	81.34
		COLS	3.430+ .266	0.519 (3.27)	0.039 (0.803)	0.253 (3.139)	0.222 (3.075)	-0.105 (0.537)	-0.033(0.36)	0.142(1.433)	0.931	81.34
Overall	Marginal	OLS	3.822	-0.017 (0.34)	-0.016 (0.54)	0.152* (5.38)	0.333* (5.51)	0.445* (5.78)	0.038 (0.60)	-0.063 (1.12)	0.841	107.07
		COLS	3.822+ .535	-0.017 (0.34)	-0.016 (0.537)	0.152 (5.384)	0.333 (5.512)	0.445(5.780)	0.038 (0.60)	-0.063 (1.121)	0.841	107.07
	Small	OLS	5.175	0.094*** (1.86)	0.062* (2.61)	0.403* (10.21)	0.323* (7.49)	-.16***(1.89)	-0.052 (1.01)	0.070***(1.91)	0.568	26.69
		COLS	5.175+ .547	0.094 (1.86)	0.062 (2.609)	0.403 (10.212)	0.323 (7.485)	-0.162 (1.888)	-0.052 (1.009)	0.070 (1.907)	0.568	26.69
	Large	OLS	5.118	0.171** (2.27)	0.026 (0.94)	0.219* (5.45)	0.322* (6.37)	0.031 (0.39)	0.070 (0.82)	0.017 (0.30)	0.762	64.83
		COLS	5.118+ .529	0.171 (2.27)	0.026 (0.942)	0.219 (5.449)	0.322 (6.374)	0.031 (0.390)	0.070 (0.82)	0.017 (0.301)	0.762	64.83

Source: Computed.

Notes: Figures in Parenthesis () show t-values. *, **, ***, shows the significant at 1 percent, 5 percent and 10 percent level of significance

Abbreviations: OLS: Ordinary Least Square, COLS: Corrected Ordinary Least Square

X_{1i} = Investment on Land Preparation (In Rs); X_{2i} = Investment on Irrigation (In Rs); X_{3i} = Miscellaneous Cost (It includes Investment in Draft Animal, Threshing and Labour cost, Phawada, Gaithi, Khurpi, Hnasiya) In Rs); X_{4i} = Investment on Seeds (In Rs); X_{5i} = Investment on FYM, Fertilizers and Insecticides and Pesticides (In Rs); X_{6i} = Proportion of family members having education up to Primary; X_{7i} = Farm Machinery Dummy variable, Own = 1, otherwise 0).

Table-22. Computation of Technical Efficiency of Different Categories of Farmers

Selected Regions	Categories of Farmers	Ln Y_i	Ln X_{1i}	Ln X_{2i}	Ln X_{3i}	Ln X_{4i}	Ln X_{5i}	Ln X_{6i}	Ln X_{7i}	$\hat{Y}$	$\hat{U}$	$-\hat{U} = \hat{U}$ - Greater value of $\hat{U}$	TE = exp (-U^)	TE (%)
Jhansi	Marginal	11.294	8.189	8.189	9.068	7.333	8.1887	0.000	1	10.991	0.303	0.000	1.00	100
	Small	12.478	8.923	7.696	10.347	8.052	8.700	-0.182	1	12.004	0.475	0.000	1.00	100
	Large	12.995	9.518	9.735	11.112	9.599	9.457	0.000	1	12.818	0.177	0.000	1.00	100
Lalitpur	Marginal	11.319	8.055	8.182	8.665	7.300	7.824	0.000	0	10.722	0.597	0.000	1.00	100
	Small	11.776	8.902	8.712	9.408	7.879	8.657	-0.693	0	11.389	0.387	0.000	1.00	100
	Large	12.514	9.518	7.972	10.694	8.304	9.247	-0.511	0	12.013	0.501	0.000	1.00	100
Jalaun	Marginal	11.359	8.476	6.397	9.102	7.155	8.378	0.000	0	11.070	0.289	0.000	1.00	100
	Small	11.832	9.000	6.802	9.699	8.189	8.716	0.000	0	11.63	0.202	0.000	1.00	100
	Large	12.967	10.060	7.601	10.275	9.776	9.680	0.000	0	12.701	0.266	0.000	1.00	100
Overall	Marginal	11.319	8.055	8.182	8.665	7.300	7.824	0.000	0	10.784	0.535	0.000	1.00	100
	Small	12.478	8.923	7.696	10.347	8.052	8.700	-0.182	1	11.932	0.547	0.000	1.00	100
	Large	12.664	9.596	9.200	9.663	8.407	9.561	0.000	1	12.135	0.529	0.000	1.00	100

Source: Computed

Ln Yi = Natural Log of Total Annual Agricultural Output (In Rs); Ln X1i = Natural Log of Investment on Land Preparation (In Rs); Ln X2i = Natural Log of Investment on Irrigation (In Rs); Ln X3i = Natural Log of Miscellaneous Cost (It includes Investment in Draft Animal, Threshing and Labour cost, Phawada, Gaithi, Khurpi, Hnasiya) (In Rs); Ln X_{4i} = Natural Log of Investment on Seeds (In Rs); Ln X_{5i} = Natural Log of Investment on FYM, Fertilizers and Insecticides and Pesticides (In Rs); Ln X6i = Natural Log of Proportion of family members having education up to Primary (In Rs); X7i = Farm Machinery (Dummy variable, Own = 1, otherwise 0).

Table-23. Categorisation of Technical Efficiency of Different Farm Sizes

Sr. No.	Districts	Farm Size Categories	Categories of Technical Efficiency (In Percent)									Total
			0.1 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	81 to 90	91 to 100	
1	Jhansi	Marginal	-	-	-	-	-	1 (200)	15 (30.00)	21 (42.00)	9 (18.00)	4 (8.00)	50 (100.00)
		Small	-	-	-	-	2 (4.00)	14 (28.00)	28 (56.00)	5 (10.00)	-	1 (2.00)	50 (100.00)
		Large	-	-	-	-	-	-	2 (4.00)	9 (18.00)	26 (52.00)	13 26.00)	50 (100.00)
2	Lalitpur	Marginal	-	-	1 (2.00)	4 (8.00)	13 (26.00)	16 (32.00)	7 (14.00)	4 (8.00)	4 (8.00)	1 (2.00)	50 (100.00)
		Small	-	-	-	3 (6.00)	4 (8.00)	4 (8.00)	12 (24.00)	18 (36.00)	4 (8.00)	5 (10.00)	50 (100.00)
		Large	-	-	-	4 (8.00)	8 (16.00)	11 (22.00)	10 (20.00)	7 (14.00)	6 (12.00)	4 (8.00)	50 (100.00)
3	Jalaun	Marginal	-	-	-	-	-	2 (4.00)	13 (26.00)	18 (36.00)	13 (26.00)	4 (8.00)	50 (100.00)
		Small	-	-	-	-	-	-	2 (4.00)	19 (38.00)	22 (44.00)	7 (14.00)	50 (100.00)
		Large	-	-	-	-	-	1 (2.00)	8 (16.00)	26 (52.00)	11 (22.00)	4 (8.00)	50 (100.00)
4	Jhansi Division (Overall)	Marginal	-	-	1 (0.67)	4 (2.67)	29 (19.33)	51 (34.00)	31 (20.67)	23 (15.33)	8 (5.33)	3 (2.00)	150 100.00)
		Small	-	-	2 (1.33)	4 (2.67)	16 (10.67)	61 (40.67)	43 (28.67)	22 (14.67)	1 (0.67)	1 (0.67)	150 100.00)
		Large	-	-	2 (1.33)	8 (5.33)	13 (8.67)	53 (35.33)	53 (35.33)	14 (9.33)	5 (3.33)	2 (1.33)	150 100.00)

Source: Computed. Note: The figures in parenthesis () are percentage.

Table-24. F – Ratio for the Test of Regional Technical Equality: Chow Test

S.No.	Farm Size Category	Number of Observations	Number Of Variables	Residual Sum of Squares			F_c	F_t	$F_c > F_t$ = Hypothesis Rejected $F_c < F_t$ = Hypothesis Accepted
				Jhansi District (e_1^2)	Lalitpur District (e_2^2)	Overall (e_p^2)			
A	Comparison between Jhansi and Lalitpur Districts								
1	Marginal Farmers	50	8	0.771	3.405	5.887	4.302	1.94	Hypothesis Rejected
2	Small Farmers	50	8	0.832	3.029	5.000	3.098	1.94	Hypothesis Rejected
3	Large Farmers	50	8	0.374	4.452	5.447	1.351	1.94	Hypothesis Accepted
B	Comparison between Jhansi and Jalaun Districts								
1	Marginal Farmers	50	8	0.771	0.835	1.932	2.131	1.94	Hypothesis Rejected
2	Small Farmers	50	8	0.832	0.417	1.467	1.833	1.94	Hypothesis Accepted
3	Large Farmers	50	8	0.374	0.559	1.083	1.688	1.94	Hypothesis Accepted
C	Comparison between Lalitpur and Jalaun Districts								
1	Marginal Farmers	50	8	3.405	0.835	4.834	1.471	1.94	Hypothesis Accepted
2	Small Farmers	50	8	3.029	0.417	4.044	1.822	1.94	Hypothesis Accepted
3	Large Farmers	50	8	4.452	0.559	5.835	1.727	1.94	Hypothesis Accepted

Source: Computed

Table-25. Input-Output Ratio for Different Farm Size Categories

Sr. No.	Districts	Farm Size Categories	Y_i	Total Inputs (In Rs)						Input-Output Ratio (In Percent)					
				X_{1i}	X_{2i}	X_{3i}	X_{4i}	X_{5i}	C	X_1	X_2	X_3	X_4	X_5	Input-Output Ratio
1	Jhansi District	Marginal	3360375	132655	97950	669476	86794	168375	1155250	3.95	2.91	19.92	2.58	5.01	34.38
		Small	8142590	318936	173637	1328965	234362	308100	2364000	3.92	2.13	16.32	2.88	3.78	29.03
		Large	15372550	644390	592775	2218120	608365	627850	4691500	4.19	3.86	14.43	3.96	4.08	30.52
2	Lalitpur District	Marginal	1924143	127000	85482	362782	53011	128625	756900	6.60	4.44	18.85	2.76	6.68	39.34
		Small	6339940	360103	220911	1029509	215727	334500	2160750	5.68	3.48	16.24	3.40	5.28	34.08
		Large	15548405	963950	721172	2289553	589450	1017475	5581600	6.20	4.64	14.73	3.79	6.54	35.90
3	Jalaun District	Marginal	3385459	245910	27750	370690	98050	198550	940950	7.26	0.82	10.95	2.90	5.86	27.79
		Small	6798661	467100	59925	960730	328745	401500	2218000	6.87	0.88	14.13	4.84	5.91	32.62
		Large	19547006	1203700	155650	2442716	930109	1075575	5807750	6.16	0.80	12.50	4.76	5.50	29.71
4	Overall	Marginal	8669976	505565	211182	1402948	237855	495550	2853100	5.83	2.44	16.18	2.74	5.72	32.91
		Small	21281191	1146139	454473	3319204	778834	1044100	6742750	5.39	2.14	15.60	3.66	4.91	31.68
		Large	50467691	2812040	1469597	6950389	2127924	2720900	16080850	5.57	2.91	13.77	4.22	5.39	31.86

Source: Primary Survey.

Notes: Y_i = Total Annual Agricultural Output (In Rs); X_{1i} = Investment on Land Preparation (In Rs); X_{2i} = Investment on Irrigation (In Rs); X_{3i} = Miscellaneous Cost (It includes Investment in Draft Animal, Threshing and Labour cost, Phawada, Gaithi, Khurpi, Hnasiya) (In Rs); X_{4i} = Investment on Seeds (In Rs); X_{5i} = Investment on FYM, Fertilizers and Insecticides and Pesticides (In Rs); C = Total Annual Cost (In Rs.) on inputs.

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