



Technical efficiency of Wheat crop on different size of farms in western region of Uttar Pradesh

Anjali Jakhar, Vikrant Kumar, and Mohd. Nayeem Ali

Department of Agriculture, Shri Ram College, Muzaffarnagar

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(✉) Corresponding Author: anjali31july@gmail.com

Abstract

Uttar Pradesh is the 2nd largest state in India. The economics of Uttar Pradesh is mainly based on agriculture and about 65 % of the total population is dependent on agriculture the main crop of Uttar Pradesh is Wheat. Wheat is the state's principal food crop and sugarcane is the main commercial crop. It is produced in the largest part of the state in about 24% of agricultural Land. Taking into account the significance of the aforementioned facts to measures the technical efficiency of wheat crop on different size of farms in western region of Uttar Pradesh year 2014-15. The results of investigating technical efficiency of the sample farm households under wheat crops indicated that output produced was less than the potential output to the extent of about 23 percent in wheat respectively. On overall basis, however, much variation observed across farm size groups.

Keywords: Agriculture, Technical efficiency, Cobb- Douglas Production Function

Introduction

Agriculture plays a vital role in India's economy, as 54.6 percent of the population is engaged in agriculture and allied activities (census 2011) and it contributed 17.4 percent to the country gross value added for the year 2016-17 (at current prices). As per the land use statistics (2014-15), the total geographical area of the country is 328.7 million hectares of which reported net sown area is 140.1 million hectares and gross cropped area was 198.4 million hectares with a cropping intensity of 142 percent. The net area sown shared 43 percent of the total geographical area. There had been a continuous decline in the share of agriculture and allied sector in the gross value added from 18.6 percent in 2013-14, 18.0 percent in 2014-15, 17.5 percent in 2015-16 and 17.4 percent in 2016-17 at current prices (Agriculture Annual Report, 2017-18). The 2017 global hunger index had rated India under 'serious' category with respect to under nutrition child stunting and child birth weight India was ranked 100 among 119 countries for which global hunger index was constructed. The

population of India is projected to be 1.65 billion by 2050. Various studies indicate that the demand for food grains will grow by about 50 percent in 2050. (IFPRI, 2018). Climate change was also posing serious threat to food security in India. The intensity and extent of extreme climate events, such as drought, high rise and fall in temperature, floods, untimely and unevenly rainfall are adversely affecting agricultural production, farm incomes and food security. The available estimates reveal a loss of 10-40 percent in food production due to rise in temperature (Joshi, 2016). Various estimates suggest that India will experience an increase of 2.2 to 2.9 degree Celsius in average temperature by 2050 affecting overall production of crops. In addition, increasing demand for industrialization, urbanization, housing and infrastructure was forcing conversion of agricultural land to non- agricultural use; therefore, the scope for expansion of the area available for cultivation is limited (Saxena, 2017). The state of Uttar Pradesh had seen regular fluctuation in the growth rate in area, production and yield. The fluctuation shows the vulnerability of the sector to seasonal conditions. (Koshal, 2012). Category

wise variation in resources across the farm size groups lead to varying efficiency in production of crops. Majority of the land holdings are very small in the region. The adoption of well proven technology was constrained due to small size of holdings and poor farm resources.

The Cobb-Douglas production function was used to compute the technical efficiency. It was found that the Cobb- Douglas approximation gave a fair fit with the range of observations. The study also computed the technical efficiencies of different states. The researcher found that for each state there was a different estimate of efficiency, according to the factors of production included in the analysis [Farrell \(1957\)](#). Examined the technical efficiency, Allocative efficiency and economic efficiency for a sample of sixty farmers in the Dajabon region by using maximum likelihood techniques were used to estimate a Cobb-Douglas production frontier, which was then used to derive its corresponding dual cost frontier. These two frontiers were the basis for deriving farm-level efficiency measures [Boris \(1997\)](#). Technical inefficiency in the production of rice was negatively related with farm size, education of the farmer, experience, extension contacts and percentage of good land and positively related with age and fragmentation of the land [Reddy and Sen \(2004\)](#). Examined the technical efficiency and environmental impact of Bt cotton & Non Bt cotton in North India for the period from 2007-08, using stochastic frontier production function and the environmental impact quotient (EIQ). The results revealed that average technical efficiency was higher in Bt cotton farming. Roughly 80 percent of Bt cotton farms fall in the efficiency range of 80 to 95 percent; this figure reduced to 60 percent on Non Bt cotton farms [Manjunatha et al. \(2011\)](#). Examined the technical efficiency of cocoa production in south west Nigeria for the period 2012. The result showed that cocoa enterprise was profitable, and in terms of technical efficiency, cocoa farmers in the region were relatively production efficient Ekiti state had the highest mean efficiency relative to Ondo state and Osun state. They also reported that the years of schooling had a positive influence on the technical efficiency of farmers while area of land cultivated and age of cocoa trees had a negative influence [Graceo et al. \(2015\)](#). Examined the efficiency in foodgrains production in India for the period from 1960-61 to 2013-14, using DEA and SFA frontier approach. High average efficiency in farming operations for both the frontier methods was observed. The period after 1990 had witnessed improved agricultural performance as inferred from the frequency distribution of the efficiency scores which indicated that during this period the overall efficiency scores had been higher and there was not a single year in which the efficiency levels had been less than 90 percent [Mathur \(2018\)](#). Taking into account the significance of the aforementioned facts a study of technical efficiency in Wheat crops was planned for western region of Uttar Pradesh. So, in this case “Examine the technical efficiency of Wheat crops on different size of farms in western region of Uttar Pradesh”.

Methodology

Table 1. Major Crops grown in western region of Uttar Pradesh (2014-15)

The study was based on primary study and it is conducted in the western region of Uttar Pradesh. The technical efficiency of wheat crops of region was examined using primary data. Stratified random sampling and Cluster sampling technique had been adopted for the selection of respondent households of the western region for the agriculture year 2014-15. At the first stage out of total six divisions in the western region of Uttar Pradesh two divisions viz., Meerut Division and Aligarh Division were selected randomly. From each selected division two districts had been selected purposively, each one with highest and lowest productivity of major crops. In Meerut Division, Meerut District was selected on the basis of high productivity and Ghaziabad District was selected on the basis of low productivity District, purposively. In Aligarh Division, Aligarh district was selected on the basis of high productivity, whereas, Kashganj District was selected on the basis of low productivity district, purposively. At next stage one development block was selected randomly from each selected district. From Meerut District, Mawana development block and from Ghaziabad district, Muradnagar Development block was selected randomly. Similarly, from Aligarh district, Koil development block and from Kashganj district, Kashganj development block were selected randomly. Thereafter, one village was selected randomly from each selected development block and three adjoint villages were also included to form a cluster to select respondent farmers. At last stage sixty farmers (15 each from marginal, small, medium and large farm size groups) were selected randomly from each cluster. Hence, total sample size comprised of 240 farm households to collect primary data for the study. Under mawana development block Tigri village was selected randomly and Khalidpur, Niloha and Kareempur adjacent villages were included to form cluster. In case of Muradnagar development block Didholi village was selected randomly and Sultanpur, MohammadPur and Jalalabad adjacent villages included to form cluster. Similarly, under Koil development block Joraver Nagar village was selected randomly and Gadiyawali, Boner, Balrampur and Girdharpur adjacent villages were included to form cluster. In case of Kashganj development block Janhageerpur village was selected randomly to form a cluster with adjacent Mahawar, MohammadPur and dolna villages.

Selection of major crops

Different crops were grown in various seasons in the region; however, major crops of the region are those crops which together accounted for nearest 75 percent of the gross cropped area arranged in descending order. Major crops were selected on the basis of cropping pattern of western region of the Uttar Pradesh state in 2014-15 shown in table No. 1.

So, according to cumulative total of the percent area in term of major crops wheat, sugarcane paddy and bajra are found as major crops of the western region of Uttar Pradesh on the basis of cropping pattern 2014-15, which is shown in the

Crop	Percent of gross cropped Area	Cumulative Total
Wheat	39.00	39.00
Paddy	18.33	57.33
Sugarcane	14.33	71.33
Bajra	8.56	79.89
Potato	4.25	84.14
Maize	3.56	87.7
Urd	0.86	88.56

above table but only selected the wheat crop for measuring the technical efficiency in western region. Wheat crop was selected purposively because it consists higher area out of total gross cropped area in percent.

Analytical framework

The estimation of technical efficiency in the production of different crops was indicated as the difference in the adoption rates of technical change. It also helps to determine the effectiveness of growth-promoting institutions such as education, extension services, and credit institutions of production practices available to the farmers. Technical efficiency was examined to identify the possibilities for further increase in the output of any crop while conserving resource use. Technical efficiency refers to the proper choice of production function among all those activities used by various farmers in agriculture. Estimation of technical efficiency involved two-stage procedures. Initially, estimates are obtained of frontier function a model which is a neutrally upwardly scaled version of the ordinary least squares or average model. In the second stage, individual farm's deviation from the frontier was used to estimate the technical efficiency. This also indicates how much extra output could be obtained if a particular farm was to reach the frontier. For the measurement of technical efficiency, the uniform weighted average prices of input and output were used for all the sampled farmers. Quantities of output and input on a per hectare basis were used as the weights.

The index of technical efficiency was constructed using the following formula:

$$T.E.j = Y_j / Y^*j$$

OR

$$\ln T.E.j = \ln Y_j - \ln Y^*j \dots\dots\dots(1)$$

Where,

- T.E.j = Technical Efficiency of jth farmer
- Yj = Actual gross return in Rs./ha of jth farmer
- Yj * = Potential (maximum possible) gross return of jth farmer at present input use
- Ln = Natural logarithm

Three methods were generally used for developing frontier production function as well as for calculating potential (maximum possible) gross return i.e. Y*j. These are Linear Programming, Corrected Ordinary Least Square (COLS) Technique and Maximum Likelihood Method.

Out of these, Corrected Ordinary Least Square technique was used in the present study to develop frontier function for each farmer, because COLS technique is simple and very widely used method for developing frontier production function (Russell and Young, 1983). Due to presence of multicollinearity, per farm crop cultivation data were transformed in per hectare input use and output of for different farm size groups, calculating zero order correlation matrices.

Corrected ordinary least squares (COLS) method

The Cobb- Douglas production function, as hypothesized in equation (1) stated as followed in log form:

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} + V_i$$

Or

$$\log Y_j = a_0 + b_i X_i + V_i \dots\dots\dots(2)$$

- Where,
- Yj = Gross income from jth crop of the ith farm (Rs. per ha.)
- Xi = Level of tth variables used in jth crop (quantity /value per hectare)
- a = Constant term
- bi = Regression Coefficients of the respective resource
- Vi = Error term

After the estimation of above production function, the estimated value of lnYj * had been estimated for each farmer, using the original data set. Then residual, μj is calculated as follows:

$$\mu_j = \ln Y_j - \ln Y_j^{\wedge} \dots\dots\dots(3)$$

where,
 lnYj = Actual gross return in Rs./ha of jth farmer
 lnYj^ = gross return of jth farmer, calculated by using original input data set in above estimated production function (2).

By the equation (3) a series was found. Among all the μj , the larger positive (+) is selected and denoted as μj max. Then, the correction is made in production function (2) by sifting the

constant term upwardly by an amount equal to the value of μ_j max.

Thus the new form of production function had been come as follows.

$$\ln Y = (\ln a + \mu_j \max) + b_i \ln X_i \dots\dots\dots(4)$$

By combining the term $(\ln a)$ and $(\mu_j \max)$, a new term was found and called as “ $\ln a_0$ ”. this $(\ln a_0)$ had been assumed as the constant term for the frontier production function of estimated production function.

The form of frontier production function is as follows:

$$\ln Y = \ln a_0 + b_i \ln X_i \dots\dots\dots(5)$$

By the use of frontier production function and the farmer’s original input data set, Y_j^* estimated for each farmer. Therefore, technical efficiency of the farm households, across farm size group, had been worked out.

Result & Discussion on technical efficiency

As explained in the above section, the technical efficiency had been measured through an index of actual output of a farmer and the maximum possible output at his given level of resource use. At the first step, Cobb-Douglas production function had been estimated at the average resource use level of the sample farmers. Then the frontier production function had been obtained by finding the largest error amount (i.e., $\mu_j = \ln Y_j - \ln y_j^*$) and shifting the intercept of estimated Cobb-Douglas production function to find out the largest possible output level at the average resource use of the sample farmers.

Cropping pattern followed by sample farm households in the western region of Uttar Pradesh

In the western region the technical efficiency index had been constructed for each farm in different size group as well as for overall farm size group by estimated COLS frontier. Based on cropping pattern followed by farm households, bajra, wheat and sugarcane appeared as major crops which together contributed 70 percent of gross cropped area in the western region of the state, during 2014-15. On the basis of cumulative total of the selected crops, total three crops; viz., wheat, sugarcane and bajra emerged as the major crops of the western region of Uttar Pradesh based on primary survey wheat occupied highest area out of total gross cropped area, so Wheat crop was selected for estimating the technical efficiency on different size of farms which is shown in table 2 & 3.

Technical Efficiency in Wheat Crop

On the basis of primary survey three major crops; i.e., sugarcane, wheat and bajra, out of these wheat crop was selected for measuring the technical efficiency of the selected farm household in the western region of Uttar Pradesh. These efficiency index for each farm household category wise as well as for overall farm size are presented in appendix I. The descriptive statistics as well as the distributions of farmers (category wise) according to their technical efficiency status (in percent term) are given in tables 4, 5,6 for Wheat crop.

Table 2. Cropping pattern followed on sample farm household in western region of Uttar Pradesh during 2014-15 (Hectare per farm)

Crop	Farm Size Group				
	Marginal	Small	Medium	Large	Overall
Maize	0.03(3.17)	0.12(5.23)	0.32(7.35)	0.58(8.45)	0.2(5.62)
Jowar	0.28(27.91)	0.36(15.65)	0.46(10.66)	0.59(8.48)	0.65(18.26)
Urd	0(0.00)	0.03(1.3)	0.04(0.99)	0.1(1.4)	0.03(0.84)
Bajra	0.04(4.37)	0.34(14.78)	0.71(16.45)	1.15(16.62)	0.41 (11.52)
Wheat	0.32(31.88)	0.75(32.61)	1.35(31.20)	2.11(30.45)	1.15(32.3)
R&M	0(0.00)	0.01(0.44)	0.01(0.35)	0.06(0.88)	0.01(0.28)
Potato	0.003(0.33)	0.05(2.17)	0.09(2.14)	0.14(2.08)	0.04(1.12)
Pea	0.03(3.24)	0.05(2.17)	0.08(1.76)	0.11(1.57)	0.08(2.25)
Sugarcane	0.29(29.10)	0.59(25.65)	1.26(29.10)	2.08(30.07)	0.99(27.81)
Gross Cropped Area	1.008	2.3	4.32	6.93	3.56
Net Cultivated Area	0.65	1.45	2.79	4.15	2.29
Cropping intensity in percent	155.08	158.44	154.79	166.97	155.46

Table 3. Major Crops Grown in Western Region

Major crops in Western Region		
Crop	Area (percent to GCA)	Cumulative Total
Wheat	32.30	32.30
Sugarcane	27.81	60.11
Bajra	11.52	71.63
Maize	5.62	77.25
Potato	1.12	78.37
Pea	2.25	80.62
Urd	0.84	81.46
R & M	0.28	81.74

Figures in parentheses indicate percent to gross cropped area

Status of technical efficiency in wheat cultivation

The technical efficiency indices of individual farm households (category wise and overall farm households) were presented in

appendix II. The descriptive statistics as well as the distributions of farmers category wise household according to their technical efficiency class (in percent term) were given in tables 7,8 and 9.

Wheat production function estimates

Table 4. OLS estimates of the production function in wheat crop in western region during 2014-15

Particulars	Farm size group			
	Marginal	Small	Medium	Large
Intercept	3.416* (0.811)	2.066***(1.003)	2.408** 0.992)	5.685* (0.986)
Seed	0.876* (0.064)	0.910*(0.038)	0.991* (0.036)	0.960* (0.037)
Human labour	-0.149** (0.062)	0.286*** (0.124)	-0.055** (0.021)	-0.025 (0.043)
Irrigation	0.049 (0.069)	-0.039 (0.051)	0.069**** (0.041)	-0.005 (0.034)
Fertilizer	0.109**** (0.065)	-0.019 (0.060)	0.109 (0.07)	-0.009 (0.09)
Insecticide	-0.127**** (0.064)	-0.037 (0.044)	-0.051 (0.035)	0.027 (0.039)
Machine power	0.187****(0.097)	0.091 (0.086)	0.056 (0.071)	-0.178*** (0.083)
R square	0.92	0.98	0.91	0.99

Note : *,**,***,****indicate significance at 1, 2, 5 and 10 percent levels, respectively. Figures in particulars indicate standard errors.

In case of medium farmers, seed, human labour and number of irrigations significantly contributed to the value of gross returns. The coefficient of human labour had been found negative and significant. In case of large farmers value of seed

The estimates of Cobb Douglas production function obtained using ordinary least square technique, used to examine the technical efficiency of wheat growers in the region, are shown in table 6. The table reveals that for marginal farmers, seed, human labour, fertilizer, plant protection chemical and use of machine power significantly contributed to the value of gross returns. The coefficient of human labour had been found to be negative and significant. In case of small farmers, wheat production responded significantly and positively to the value of seed and number of human labour. It indicates that there was room for improving gross returns from wheat production by increasing the level of these inputs.

and machine power had significantly contributed to the value of gross return. The coefficient of machine power had been

found negative and significant. Results shown in tables wheat production lowest percent efficiency levels had been found as 69, 64, 73 and 72 in marginal, small, medium and large farm size groups, respectively. Highest efficiency level had been

Table 5. Descriptive statistics of Technical Efficiency of wheat crop in Western region of Uttar Pradesh based on COLS frontier model

Technical efficiency	Farm size group			
	Marginal farmers	Small farmers	Medium farmers	Large farmer
Minimum efficiency level	0.69	0.64	0.73	0.72
Maximum efficiency level	0.99	0.90	0.99	0.99
Mean efficiency level	0.85	0.77	0.81	0.87
Variance	0.005	0.004	0.004	0.01
Standard deviation	0.08	0.06	0.06	0.07
Coefficient of variation	8.97	8.69	7.43	8.44

found more than 90 percent and above across the farm size groups except small farmers.

In marginal farm households only 30 percent of the farmers were found in the range of 71 to 80 percent efficiency level. Most of the farmers, about 46.66 percent, had been found 81-

90 percent efficient; whereas, 21.67 percent of the farmers were in the range of 90-100 percent efficiency level. The

mean efficiency level of the marginal farmers in the wheat production observed 85 percent indicating that, on an average, about 15 percent less output was being produced as compared to the frontier (potential) level of output.

Table 6. Descriptive statistics of technical efficiency of wheat crop based on COLS frontier model in Western region of Uttar Pradesh (Number)

T.E. Rating (%)intervals	Farm size group			
	Marginal	Small	Medium	Large
61-70	1 (1.67)	14 (23.33)	0 (0.00)	0 (0.00)
71-80	18 (30.00)	29 (48.34)	28 (46.67)	14 (23.33)
81-90	28 (46.66)	17 (28.33)	27 (45.00)	25 (41.67)
91-100	13 (21.67)	0 (0.00)	5 (8.33)	21 (35.00)

Note: Figure in parentheses show percent to total number of sample farm households

Among small farm households about 23.33 percent of the farmers had been found efficient between 61-70 percent. Most of the farmers, percent, were found between 71 to 80 percent efficient. Only 28.33 percent of the farmers were in the 81-90 percent efficiency level. The mean efficiency level of the small farmers in the wheat production had been about 78 percent indicating that, on an average, about 22 percent less output was being produced as compared to the frontier (potential) level of output.

Among medium farm households most of the farmers, about 46.67 percent, found 71-80 percent efficient. Forty -five percent of the farmers found efficient in the range of 81-90 percent efficiency. Only 8.33 percent of the farmers were in the 91-100 percent efficiency level. The mean efficiency level of the medium farmers in the wheat production was observed 82 percent indicating that, on an average, about 18 percent less output was being produced as compared to the frontier (potential) level of output, by the medium farmers.

Among large farm households about 23.33 percent of the farmers had been found efficient between 71-80 percent. Most of the farmers, 41.67 percent, are found in the range of 81 to 90 percent efficiency. However, 35.00 percent of the farmers were in the 91-100 percent efficiency level. The mean efficiency level of the large farmers in the wheat production observed as 87 percent indicating that, on an average, about 13 percent less output is being produced as compared to the frontier (potential) level of output.

Policy Implication

On the basis of above findings, it was concluded that there was a need to introduce suitable innovation in the region to increase the productivity of Wheat. The result of investigation of technical efficiency of the sample farms under Wheat crop indicates that 23 percent less than the potential output was being obtained on the medium farm households. There was scope for use of more tractor power, human labour, seed and fertilizer in wheat which may help to produce potential level of output. Hence, further emphasis was required on Wheat crop. So, it was a matter of concern for the policy makers

Appendix I: Technical efficiency indices of Wheat producer obtained by COLS method in Western region of Uttar Pradesh during 2014-15

Farm size group					
Sl.No.	Marginal	Small	Medium	Large	Overall
1	0.8012	0.8853	0.8689	0.7736	0.7756
2	0.8468	0.7887	0.7400	0.9180	0.7343
3	0.9643	0.7825	0.8250	0.9025	0.8488
4	0.8461	0.6410	0.9724	0.7899	0.7367
5	0.9886	0.6880	0.8435	0.8619	0.8647
6	0.9399	0.8011	0.8793	0.8883	0.8899
7	0.7744	0.7553	0.7416	0.7821	0.6588
8	0.7967	0.9022	0.7517	0.8507	0.6924
9	0.8219	0.9005	0.8139	0.8270	0.7314
10	0.9553	0.8434	0.7972	0.8891	0.8010
11	0.9933	0.6815	0.8161	0.9129	0.8533
12	0.8818	0.7607	0.7760	0.8469	0.7536
13	0.8621	0.7713	0.7388	0.9140	0.7299
14	0.8389	0.8314	0.8242	0.8898	0.7150
15	0.9871	0.7037	0.8070	0.7826	0.8808
16	0.8399	0.7836	0.8001	0.9906	0.7573
17	0.8167	0.7222	0.7820	0.9485	0.6976
18	0.9057	0.9002	0.7392	0.9925	0.7629
19	0.7564	0.6933	0.8062	0.7825	0.6701
20	0.7757	0.7860	0.7966	0.7786	0.6561
21	0.887	0.7041	0.9922	0.8923	0.7924
22	0.7755	0.7345	0.8369	0.8866	0.7153
23	0.8361	0.7125	0.8612	0.9123	0.7826
24	0.7603	0.7273	0.7991	0.9839	0.6593
25	0.6993	0.7665	0.7968	0.9749	0.6506
26	0.7961	0.7447	0.7880	0.8820	0.7907
27	0.8733	0.8157	0.8070	0.7316	0.7575
28	0.8148	0.7832	0.7482	0.9144	0.7106
29	0.7917	0.7648	0.9003	0.7780	0.6974
30	0.8193	0.8944	0.8452	0.8487	0.6989
31	0.8735	0.8387	0.8836	0.7707	0.8721
32	0.8089	0.7840	0.7454	0.9673	0.7263
33	0.9263	0.7418	0.8549	0.8832	0.8745
34	0.9005	0.6690	0.9669	0.8124	0.8115
35	0.9324	0.6856	0.8351	0.9397	0.8454
36	0.9655	0.7819	0.8753	0.8909	0.9642
37	0.8538	0.6821	0.7502	0.7278	0.7664

38	0.8373	0.8478	0.7806	0.8276	0.7934
39	0.7613	0.8442	0.7962	0.8144	0.7118
40	0.9457	0.7907	0.8026	0.8847	0.8402
41	0.9833	0.7030	0.8244	0.9707	0.8951
42	0.9852	0.8001	0.8127	0.8245	0.9244
43	0.7715	0.7753	0.7781	0.8950	0.6801
44	0.8518	0.8193	0.8016	0.8437	0.7739
45	0.9870	0.6754	0.7649	0.8217	0.9282
46	0.8432	0.7653	0.8205	0.9896	0.8112
47	0.8120	0.6978	0.8127	0.8841	0.7263
48	0.8983	0.9009	0.7857	0.9724	0.8003
49	0.7575	0.6682	0.7769	0.7815	0.7267
50	0.7693	0.7942	0.7838	0.7678	0.6883
51	0.8531	0.7038	0.9809	0.9283	0.7690
52	0.7806	0.7842	0.8396	0.8787	0.7282
53	0.8930	0.7997	0.8621	0.9183	0.8395
54	0.7681	0.8100	0.8271	0.9296	0.6926
55	0.8614	0.8696	0.8196	0.9241	0.8244
56	0.8735	0.7414	0.7376	0.8532	0.8721
57	0.8475	0.8271	0.7743	0.7298	0.7952
58	0.7601	0.7961	0.7309	0.9511	0.6861
59	0.7241	0.7812	0.9083	0.7710	0.6742
60	0.7601	0.8454	0.8605	0.9511	0.6867
61					0.9928
62					0.8525
63					0.7050
64					0.7732
65					0.7647
66					0.8327
67					0.7138
68					0.6923
69					0.9377
70					0.9207
71					0.7932
72					0.7091
73					0.8334
74					0.8048
75					0.7630
76					0.7965
77					0.6901
78					0.7264

79					0.8344
80					0.6828
81					0.6630
82					0.6606
83					0.7778
84					0.8684
85					0.8353
86					0.7876
Average T.E.	0.8506	0.7749	0.8182	0.8706	0.8746

Appendix II: Zero Order correlation matrix between independent variable and dependent variable for Marginal farmers of Wheat crop in Western region

	X1	X2	X3	X4	X5	X6	Y
X1	1						
X2	0.093303	1					
X3	0.195452	0.175151	1				
X4	0.156546	0.076561	0.162632	1			
X5	0.034041	-0.09366	-0.43657	-0.17842	1		
X6	-0.01846	0.027789	0.086171	-0.05433	0.1540084	1	
Y	0.226131	0.168144	0.150651	0.082132	0.147135	0.184992	1

Appendix III: Zero Order correlation matrix between independent variable and dependent variable for small farmers of Wheat crop in Western region

	X1	X2	X3	X4	X5	X6	Y
X1	1						
X2	0.090114	1					
X3	-0.07947	0.042292	1				
X4	0.070919	0.178096	-0.26057	1			
X5	-0.14415	0.132085	0.45128	0.18303	1		
X6	0.187053	0.193128	-0.2983	0.186378	0.206861	1	
Y	0.257485	0.240122	0.048976	0.205871	0.177611	0.239037	1

Appendix IV: Zero Order correlation matrix between independent variable and dependent variable for Medium farmers of Wheat crop in Western region

	X1	X2	X3	X4	X5	X6	Y
X1	1						
X2	0.195943	1					
X3	0.106171	0.120586	1				
X4	0.008815	0.017095	0.031553	1			
X5	-0.05199	-0.04366	0.068569	0.024927	1		
X6	0.0971	0.096935	0.124044	0.059915	-0.27599	1	
Y	0.360949	0.386052	0.136811	0.225433	0.047343	0.43289	1

Appendix V: Zero Order correlation matrix between independent variable and dependent variable for large farmers of Wheat crop in Western region

	X1	X2	X3	X4	X5	X6	Y
X1	1						
X2	0.195943	1					
X3	0.106171	0.120586	1				
X4	0.008815	0.017095	0.031553	1			
X5	-0.05199	-0.04366	0.068569	0.024927	1		
X6	0.0971	0.096935	0.124044	0.059915	-0.27599	1	
Y	0.360949	0.386052	0.136811	0.225433	0.047343	0.43289	1

Note: X1 = Expenditure on seed per ha.
 X2 = Expenditure on human labour per ha.
 X3 = Expenditure on irrigation charges per ha.
 X4 = Expenditure on fertilizer per ha.
 X5 = Expenditure on ppc per ha.
 X6 = Expenditure on tractor power per ha.
 Y = Gross return in Rs. Per ha.

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