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# Technical Efficiency And Its Determinants In Wheat Production: Evidence From The Southern Punjab, Pakistan

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**Abstract:** The study estimates technical efficiency of wheat farms and its influencing socio-economic factors. The economic factors discussed in this study include farm type (ownership), farm size and farm machinery, and social factors include farmers' age, qualification, experience, and working style. Data Envelopment Analysis has been used to estimate technical efficiency of wheat. The farm level data was collected from the agriculture farms from two districts of Southern Punjab i.e., Dera Ghazi Khan and Rahim Yar Khan. Kruskal Wallis and Bonferroni comparison tests were performed to see the influences of socio-economic factors on farms' technical efficiency. It was found that technical efficiency is significantly influenced by farm type, farm size, and farmers' education and their working experience. The results showed that among the studied farms rented farms were the more efficient whereas the owners' farms are the least efficient and therefore imply that ownership has negative relation with wheat farms efficiency. Similarly, farm size also has negative and linear relation while education and experience have positive but non-linear relation with the wheat farms' efficiency. The economic factor; agricultural farm machinery showed a negative effect on the technical efficiency but this effect is insignificant. Similarly, farmers' age has negative and linear relation with the technical efficiency. Lastly, the part time working farms are more efficient than full time working farmers.

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## 1. Introduction

Wheat is one of the major food crop in Pakistan, playing important role in food security. There are number of factors affecting wheat production including area under wheat cultivation, farm size, varieties, insecticides, fertilizers, sowing time (Waqas et al., 2014; Nawaz et al., 2015; Sattar et al., 2015). Efficient use of resources are key to attain higher profitability and sustainable wheat production. Economic factors, namely farm type (tenure or ownership), farm size, farm machinery and socio-environmental factors, namely infrastructure, markets, government policies and international trade contribute directly or indirectly in efficient wheat production (Passel et al., 2006; Akhtar et al., 2015). Moreover, a number of activities such as selection of seed, varieties, fertilizers, pesticides/weedicides, seed bed preparation, amount and quality of irrigation water influence the crop production. Al-Ghobari (2013) stated that the water use efficiency under intelligent irrigation system is higher than conventional irrigation system. Similarly, Leshoro (2013) found that literacy rate and human development index have positive effects on the crop productivity in the long-run and short-run respectively. Therefore, efficient wheat farming can ensure better wheat production.

The most efficient farmer would be one who chooses the input bundle which contributes to a maximum feasible bundle of output(s) or inversely chooses a smallest possible input bundle that can produce a given level of output or some combination of the two. It is very important to identify the bundles of inputs which improve the efficiency of crop production. In this realm, this paper contributes by estimating the efficiency and by identifying its influencing economic and social factors.

Efficiency can be described in different terms such as technical efficiency (TE), scale efficiency (SE) and allocative efficiency (AE). TE is a comparison between observed and optimal values of inputs and outputs of a production units (Sadoulet and Janvry, 1995). Therefore, this comparison gives the ratio of observed to that of maximum potential output which is attainable from the given inputs, or it is the ratio of minimum potential to that of observed input(s) which are required to produce given amount of output(s), or it may be the combination of the two. A production unit is technically not efficient when it is unable to produce maximum possible output(s), (Sadoulet and Janvry, 1995). In the present study, TE-VRS (Technical Efficiency-Variable Return to Scale) has been considered. Although a number of studies could be found such as (Kiani, 2008; Javed, et al., 2010; Buriro, et al., 2013; Boris et al., 2007) which have focused the estimation of TE of wheat, rice or other agricultural crops in Pakistan, however, rarely focused on TE and its determinants in the Southern Punjab, Pakistan.

## 2. Methodology

The study used the cross-sectional data collected with the help of a well-structured questionnaire in one of the most important wheat growing areas of Pakistan located in District Dera Ghazi Khan and Rahim Yar Khan in the Southern Punjab. Information on wheat production and farm inputs including land, fertilizer (urea, di-ammonium phosphate), pesticides, and weedicides was collected from 148 farmers from selected districts.

In order to avoid the multi-collinearity and other related problems, urea and di-ammonium phosphate were added together as total fertilizers, because farmers mostly apply these two fertilizers. Similarly, we added pesticides and weedicides into one variable i.e. crop protection chemical. Therefore, land, total fertilizers, and crop protection chemicals were considered for data examination. All of the variables were measured in absolute values using international standard units. Output was recorded in kilograms while land was taken in acres, total fertilizers were recorded in kilograms and plant protection chemicals were recorded as total number of acres sprayed. In addition to these input and output variables, socio-economic data of the farms and farmers was also collected. The socio-economic data have been used to make inferences about wheat farms accordingly. We consider specification of socio-economic factors including land tenure status, farm size, ownership of farm machinery, age, education, farming experience and time allocated to farming.

### 2.1 Empirical methods

TE can be input or output oriented depending upon the decision making power of the farmers. In this study, farmer or farm manager was the decision maker who has control over input(s) but not over output(s). Therefore, input oriented TE has been considered in this study. Moreover, in order to consider the return to scale, variable return to scale (VRS) has been considered. We used data envelopment analysis (DEA) technique to estimate TE of wheat farms using DEA-Max software based on seminal works of Debreu (1951), Farrell (1957) and Shephard (1970).

Efficiency scores calculated by DEA model can be 0 to 1. DEA uses its basic assumptions to estimate the potential output of the decision making units (DMU) while considering the output of most efficient DMU's within the sample which are similar to the DMU of interest. In case of variable returns to scale, DEA identifies the efficient DMU's within the sample, whose convex combination of input(s) endowments, being equal to that of the DMUs of interest, and it produces at least not less of each output than the DMU of interest.

Let us consider:

$x^j = (x_1^j, x_2^j, x_3^j, ..., x_n^j)$ be the bundle of n inputs used and $y^j = (y_1^j, y_2^j, y_3^j, ... y_m^j)$ be the bundle of m outputs, produced by farm j (j = 1, 2, 3,..., N). Suppose that k is the observed farms and we want to measure the TE of farm 'k'. The observed input-output bundle of farm 'k' is $(x^k, y^k)$. Then the correspondent mathematical (algebraic) formula for TE will be

max φ such that

$$\sum_{J=1}^{N} \lambda jXij \leq Xik \quad (1)$$

Where i = 1, 2,3, … n)

$$\sum_{J=1}^{N} \lambda jXrj \geq \varphi Yrk \quad (2)$$

Where r = 1, 2,3, … m)

$$\sum_{J=1}^{N} \lambda j = 1; \lambda j \geq 0 \quad (3)$$

Where j = 1, 2,3, … N) $\varphi$ is unrestricted

Hence TE of farm k would be measured by

$$\tau k = \frac{1}{\varphi *} \quad (4)$$

Here λ is the efficiency measure to be calculated for each DMU j, φ is TE measure and φ* is the optimum solution of the DEA linear programming problem given above.

It would be better to define the production possibility set constructed from the sample data set D = {$(x^j, y^j)$; j= 1, 2, ,3 ...,N}. The sample estimate of the underlying production possibility set 'S' is:

$$S = \{(x, y): x \geq \Sigma Nj = 1\lambda jxj; y \leq \Sigma Nj = 1\ \lambda jyj; \Sigma Nj = 1\ \lambda j = 1; \lambda j \geq 0\ \} \quad (5)$$

Where j= 1, 2,3 ...,N

After estimation of the TE of farm, a measure of output oriented TE ($TE^o$) of a firm with observed input and output bundle ($x^k$, $y^k$) is

$$\tau^y k = \frac{1}{\varphi *} \quad (6)$$

where $\varphi^* = \max \varphi : (x^k, \varphi y^k) \in S$

The above model gives the $TE^o$ in the output oriented context.

When the input conservation is regarded as more important than expanding the outputs, the appropriate measure of performance of firm 'k' would be its input oriented TE ($TE^i$).

$$\tau^x{}_k = \theta^* = \min \theta : (\theta x^k, y^k) \in S \quad (7)$$

$TE^i$ can be then presented through the mathematical (algebraic) as:

min θ s.t.

$$\sum_{J=1}^{N} \lambda jXij \leq \theta Xik \quad (8)$$

Where i = 1, 2,3, … n

$$\sum_{J=1}^{N} \lambda jYrj \geq Yrk \quad (9)$$

Where r = 1, 2,3, … m

$$\sum_{J=1}^{N} \lambda j = 1; \lambda j \geq 0 \quad (10)$$

Where j = 1, 2,3, … N, $\varphi$ is unrestricted

Here θ denotes the efficiency measure in input oriented context.

After estimating the TE scores, our next task is to determine the influences of different factors on TE. Kruskal-Wallis test is the best for analysis in this study. Moreover, Bonferroni comparison test is best to compare the groups which are more than two in number and it compares each pair. Hence Bonferroni comparison test also has been used to compare the pairs of the ranks.

## 3. Results and Discussion

This section describes; descriptive statistics of inputs/outputs for wheat production, technical efficiency scores of wheat farmers, and influences of socio-economic factors on the wheat production. Table 1 shows the descriptive statistics of inputs/outputs for wheat production. As per results, on the average, wheat farms in the study area have 10.20 acres of land.

Out of total 142 farms, a farm with minimum land has one acre where as a farm at maximum has 40 acres of land. Similarly, on the average, a farm with 10.20 acres of land uses 2094.72 kilograms of fertilizers and each farmer spray 12.47 acres for wheat production. As a result, each farmer gets 16160.90 kilograms of wheat grains. In the following, descriptive statistics and frequency distribution of TE and the influences of the socio-economic factors of TE of wheat farms have been described. Table 2 shows the descriptive statistics of TE scores of wheat farms. Results show that the mean TE score is 0.736 with a standard deviation of 0.155. The maximum TE score is estimated to be one and the minimum is 0.417.

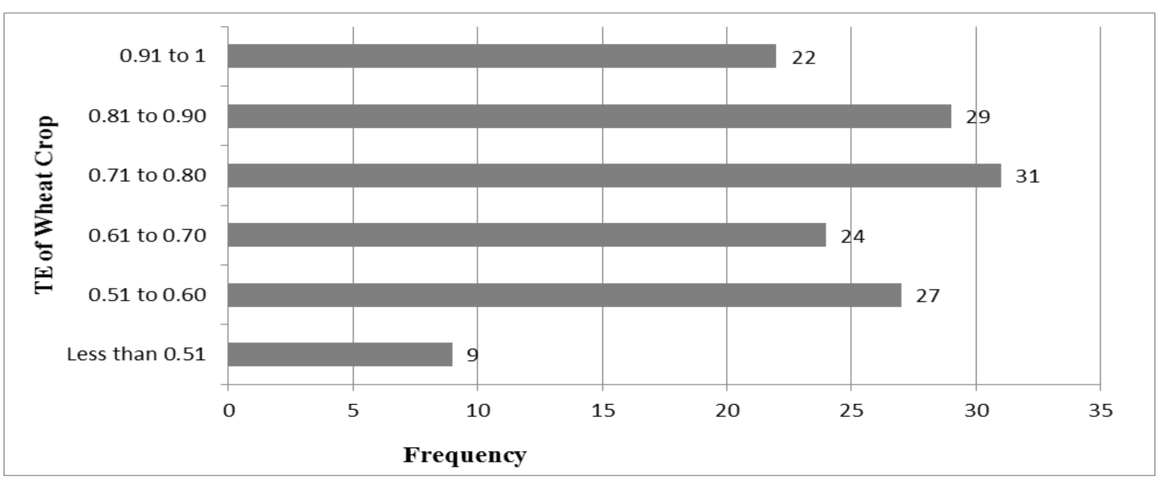


**Figure 1. Frequency distribution of wheat farms TE**

**Table 1. Descriptive Statistics of Inputs/Output of wheat**

| | Land (Acres) | Fertilizers (kg) | Chemicals (Acre × No of Sprays) | Wheat Grains (kg) |
|---|---|---|---|---|
| Mean | 10.20 | 2094.72 | 12.47 | 16160.99 |
| Standard Error | 0.76 | 156.31 | 1.11 | 1261.07 |
| Median | 7.00 | 1325.00 | 8.50 | 10040.00 |
| Mode | 4.00 | 1000.00 | 4.00 | 8000.00 |
| Standard Deviation | 9.03 | 1862.67 | 13.19 | 15027.36 |
| Sample Variance | 81.58 | 3469530.86 | 174.06 | 225821664.27 |
| Minimum | 1.00 | 250.00 | 0.01 | 1600.00 |
| Maximum | 40.00 | 10000.00 | 80.00 | 96000.00 |
| Count | 142.00 | 142.00 | 142.00 | 142.00 |
| Confidence Level (95, 0%) | 1.50 | 309.02 | 2.19 | 2493.05 |

Mean TE scores are too low for the present study, implying that farmers growing wheat can increase wheat production from the available farm resources and technology through better management practices. Doing this will not only increase crop production but it will also save scarce resources.

Figure 1 shows frequency distribution of TE of wheat farms. Findings show that a few farms (only 51, out of 142 farms) achieve the TE score more than 80%, whereas 82 farms achieve the TE between 50% and 80% and there are nine wheat farms achieving TE scores even lesser than 50%. It means that potential exists to improve wheat production by adapting better management practices. In order to see the influences of socio-economic factors, Kruskal Wallis and Bonferroni comparison test was taken. Results are given in Table 3.

### 3.1 Influences of Agricultural Farm Type (AFT) on TE of wheat farms

Agricultural farm type has statistically significant influences on TE of wheat farms. Out of 142 farms, owners, owner-renters, and renters farms were counted to be 104, 24, and 14, respectively. According to Kruskal Wallis test, the owners, owner-renters, and renters farms have the mean TE scores of 0.715, 0.746 and 0.874, respectively. So the owners are found to have minimum mean TE score, whereas the renters have maximum mean TE score.

The value of $\chi2$ is 13.078, indicating that difference among the groups is large and it is statistically significant too. According to Bonferroni test, the difference between owners and owner-renters is very less i.e. 0.031 with statistically non-significant p value (1.000). But the difference between the owners and renters was found as 0.159 with p value as 0.001 i.e., difference is large and it is statistically significant too, while difference between mean of owner-renters and renters is 0.129 with p value of 0.033, indicating that difference is large and it is statistically significant. Hence, renters' farms are technically the best one whereas the owners' wheat farms are technically least efficient. The logic behind such results is that the renters are mostly those farmers which like agriculture farming and their liking is derived from their personal and family labor. Therefore, in order to get their family and themselves employed, farmers having no or few acres of land get more land on rent from other land holders. Such farmers are very enthusiastic for agriculture farming and work very hard. Hence, they get more production constituting higher TE. These results are very similar to the results concluded by Helfand and Levine (2004) and Mathijs and Vranken (2001).

### 3.2 Influences of Agricultural Farm Machinery (AFM) on wheat farms TE of

Results presented in Table 3 show that only 38 farms, which consists of 13% of total farms, had their own tractors whereas 104 farms, 87% of total, did not have personal AFM and such farmers were found using AFM on rent. The farms without AFM have the mean TE score of 0.744 while mean TE score of the farms with AFM is 0.714. It indicates that the farms without AFM are technically more efficient or careful about timely use of AFM machinary to reduce rent expenses. The difference between the mean of two groups is found to be -0.030. According to Kruskal Wallis test, AFM has very small influence on the TE of wheat farms as the value of $\chi^2$ is 1.285 with prob. > $\chi^2$ as 0.257. Hence, the difference between two groups is statistically non-significant.

Chisango and Obi (2010) studied the effects of AFM on the farm production and found that AFM has some positive relation with the farms' efficiency, however, our results are different from such studies. In this case labor work which is alternative to the work by AFM has riding effect over AFM. This might be due to less availability of AFM or these farms use family labor for crop production.

**Table 2. Descriptive Statistics of TE scores of wheat growers**

| Descriptive Statistics | TE score |
|---|---|
| Mean | 0.736 |
| Standard Deviation | 0.155 |
| Minimum | 0.417 |
| Maximum | 1 |
| No. of observations | 142 |

On the average Agricultural Farm Size (AFS), in the study area is approximately 13 acres and wheat is cultivated on 77% of total land at farm, hence, it is difficult for such farmers to have personal AFM to deal with. Therefore, such farmers have managed their farms by employing maximum labor instead of managing expensive AFM.

### 3.3 Influences of Agricultural Farm Size on TE of Wheat

Results (Table 3) highlighted that small wheat farms (47 in total) get maximum mean TE score as 0.787, while the medium farms have the mean TE score of 0.717 and the large farms achieve the mean TE score of 0.669. The $\chi^2$ value was found to be 8.286 with prob. > $\chi^2$ as 0.016. This indicates that the difference between the groups is large and it is statistically different. Hence, the small wheat farms located in the studies region found to be technically efficient as compare to the large wheat farms.

According to the Bonferroni test, the biggest difference is found between the small and large farms, whereas the significant difference between the small and medium farms is found to be -0.070 with p value of 0.037. The difference between the medium and large farms is very small and it is statistically not significant (p value =0.971). Conclusively, wheat farm size has significant but negative and linear relation with the TE i.e. the smaller wheat farms are more efficient than the large wheat farms.

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Logically, small farmers are more efficient due to a number of reasons. First, almost all of the small farms are self-operated and the farmers work at farms themselves with the family members (labor). Secondly, as the total fertilizers and chemicals used at small farms are lesser (in amount) than the large farms, so the small farmers are able to apply these inputs efficiently. Therefore, the small farmers get more production as compared to large farmers, hence, more efficient. The results found in this study are very similar to the studies conducted by Odoul et al. (2006) but opposite to the results achieved by Akhtar et al. (2015).

**Table 3. Impact of Socio-economic factors on TE**

| Factors | Type/Levels | Kruskal Wallis Test | | | | Bonferroni comparison test | |
|---|---|---|---|---|---|---|---|
| | | Farms | Mean TE | $\chi^2$ | Prob > $\chi2$ | Differences | Prob. |
| **Agricultural Farm Type** | Owners | 104 | 0.715 | 13.078 | 0.001 | 0.031 (1,2) | 1.000 |
| | Owner-Renters | 24 | 0.746 | | | 0.159 (1,3) | 0.001 |
| | Renters | 14 | 0.874 | | | 0.129 (2,3) | 0.033 |
| **Agricultural Farm Machinery** | Farms without Tractors | 104 | 0.744 | 1.285 | 0.257 | -0.030 (1,2) | 0.301 |
| | Farms with Tractors | 38 | 0.714 | | | | |
| **Farm size** | Small | 47 | 0.787 | 8.286 | 0.016 | -0.070 (1,2) | 0.037 |
| | Medium | 84 | 0.717 | | | -0.118 (1,3) | 0.064 |
| | Large | 11 | 0.669 | | | -0.048 (2,3) | 0.971 |
| **Farmers' Age** | 18 to 30 Years | 34 | 0.746 | 2.141 | 0.343 | -0.003 (1,2) | 1.000 |
| | 31 to 45 Years | 80 | 0.743 | | | -0.043 (1,3) | 0.834 |
| | 46 to 65 Years | 28 | 0.703 | | | -0.040 (2,3) | 0.715 |
| **Farmers' Qualification** | Uneducated | 22 | 0.711 | 8.332 | 0.040 | 0.062 (1,2) | 0.591 |
| | Basic Level Education | 67 | 0.774 | | | -0.009 (1,3) | 1.000 |
| | High School or College Level Education | 43 | 0.702 | | | -0.024 (1,4) | 1.000 |
| | University Education | 10 | 0.688 | | | -0.071 (2,3) | 0.106 |
| | - | - | | | | -0.086 (2,4) | 0.587 |
| | - | - | | | | -0.015 (3,4) | 1.000 |
| **Farmers' Experience** | 0 to 5 years | 8 | 0.649 | 9.415 | 0.009 | 0.118 (1,2) | 0.109 |
| | 6 to 20 years | 82 | 0.767 | | | 0.053 (1,3) | 1.000 |
| | More than 20 years | 52 | 0,702 | | | -0.065 (2,3) | 0.049 |
| **Farmers Working Style** | Full Time | 134 | 0.733 | 0.684 | 0.408 | 0.059 (1,2) | 0.296 |
| | Part Time | 8 | 0.792 | | | | |

### 3.5 Influences of farmers' age on TE of wheat farm

Age of the farmers can affect TE through the decisions made by farmers in choosing the input bundles. After analysis, it was found that the most young farmers (34 in total) whose ages are among 18 to 30 years, have the maximum mean TE score (0.746) whereas the most old farmers (28 in total) with ages in the range of 46 to 65 years, are found to have the minimum mean TE score of 0.703. The middle aged farmers (31 to 45 years) have the mean TE score of 0.743. The $\chi^2$ value is found to be 2.141 with prob. > $\chi^2$ of 0.343 i.e. statistically not significant. Similarly, according to Bonferroni test very small and statistically insignificant differences is estimated. However, the younger farmers are more efficient as compared to the old farmers. Empirically, the young farmers are mostly willing and capable too, to adapt the technical innovations whereas the old farmers are sticky with the old traditions and are not willing to adopt the technical innovations. Such behavior of the farmers is mostly found in less advanced countries. Results of the study are very similar to the results of Battese and Coelli (1995), Thirtle and Holding (2003) and Parikh, et al. (1995).

### 3.4 Influences of farmers' qualification on TE of wheat farms

The qualification may have positive effects on the TE such that the qualified farmers are more informed and updated about the market information in addition to the knowledge of new varieties or new technologies invented. The Kruskal Wallis and Bonferroni test results indicate that farmers' qualification has significant but nonlinear influence on TE. The $\chi^2$ value is calculated as 8.332 with prob. > $\chi^2$ as 0.040. The most highly qualified farmers get the minimum mean TE score i.e. 0.688 while the farmers educated up to basic level have the maximum mean TE to be 0.774. The uneducated and high school level educated farmers achieve the mean TE score of 0.711 and 0.702 respectively. According to Bonferroni test, the biggest difference is found between the basic level and highly educated farmers i.e. .086. No significant difference is found between any of the two groups of farmers based on education. However, farmers' qualification has a significant but nonlinear relationship with the TE of wheat crop i.e. first increasing and then declining as the schooling years increase. The decline is more steeper as compared to the incline i.e. farmers having basic level education are the most efficient and farmers having highest level of education are least efficient. Practically, the highly educated farmers do not work themselves while the uneducated or less educated farmers work at their farms. Conceptually, the higher education is not the drawback that may cause the inefficiency. Actually, such farmers have some other alternatives to earn their livings and they do not focus on farming properly. In the literature, a number of studies are found showing a positive relation of education with the farm efficiency such as Parikh et al. (1995), Mathijs and Vranken (2001) and Igliori (2005). As pointed out by Lockheed et al. (1980) that the effects of education are much more likely to be positive in modern agriculture environments than in traditional ones. Hence, so far, in our study the agriculture farming is not modernized, education does not show the similar results as explained by the researchers in the literature.

### 3.6 Influences of farmers' experience on TE of wheat farms

According to the results, farmers' experience has significant influence on the TE of wheat crop. The middle level experienced farmers achieve the maximum mean TE score while the low level experienced farmers have the minimum mean TE score and the farmers having high experience are found to have the mean TE score of 0.702. It can be said that most of the middle experienced farmers are young and have much energy to work, so, consequently it is quite possible that such farmers are the most efficient. The $\chi^2$ value shows that the differences among the farmers' experience groups are statistically large. According to Bonferroni test, the maximum difference is found between the least experienced and middle experienced farmers (as 0.118) but it is not significant while the difference between middle and highly experienced farmers is small but significant. The minimum difference is found between the least and highly experienced but statistically, it is not significant. These results are similar to those of Thirtle and Holding (2003) and Herdt and Mandac (1981). O'Neill et al. (2002) argue that the farmers are more efficient up to the age of 49 years and according to Liu and Zhuang (2000) farmer's efficiency inclines up to age of 40 years and later declines. Hence, the experience is related with the age and it has positive effect up to some age level and later it decreases as the age of the farmers increases.

### 3.7 Influences of farmers' working style on TE of wheat farms

The influences of farmers' working style on TE of wheat is very clear. The mean TE scores achieved by full time and part time working farmers are 0.733 and

0.792, respectively. These results imply that the farmers working as part time are better than the farmers working as full time. The difference between the means is 0.059 with prob. of 0.296.

The $\chi^2$ value found by Kruskal Wallis test is 0.684 with prob. > $\chi^2$ as 0.408, indicating that the difference between the groups is small and it is statistically not significant. In the literature, it is difficult to find some results about the effects of full or part time working in the agriculture farms. Although, conceptually, it is opposite such that the full time working farmers may give more attention towards their corps but in the study area, the farmers face a lot of problems with reference to cash or money.

The farmers, who work solely on the farms as full time job, get the revenue or cash at the end of season or at the time of harvesting the crop so they are mostly deficient with the credit to buy the inputs well in time. On the other hand the farmers, who work as part time on their farms, mostly do some other work to earn the money on monthly or weekly basis and therefore, they can spend this money for buying the inputs well in time. It should be noted that the farmers working as part time, mostly have their family labor at their back which can work and take care of the crops. On the other hand, financial problem are faced by the farmers who are working solely on the farms. Hence, they are less efficient as compared to the farmers, who work as part time.

**4. Conclusion**

The study empirically finds that technical efficiency is significantly influenced by the socio-economic factors i.e. farm type, farm size farmers' education and farming experience. The results show that technical efficiency has negative relation with ownership. Moreover, farm size has negative and linear relation to wheat farms efficiency. The wheat farming in Punjab is done for subsistence needs and farmers with small holding give high value and concentration to wheat production, whereas, the large farm owners are either absentee landlords and have other occupations or give more attention to second crop, usually cash crop like cotton, and don't put more emphasize on wheat crop. Education has positive but non-linear relation with the wheat farms efficiency whereas farming experience has positive but nonlinear relation with the wheat farms' efficiency.

Farmers having less experience are relatively young with active involvement in farming are the most efficient and the farmers having more experience are less efficient due to less active engagement in farming decisions and primitive practices. Farm machinery show a negative effect on the technical efficiency but this effect is non-significant because of availability of cheap labor and large family size in combination with lack of non-farming employment opportunities don't give mechanization any significant influence. Lastly, the part time working farms are more efficient than full time working farmers. The part time farmers may be better able to invest on inputs and can make choice of purchase, whereas farmers solely dependent on farming don't have cash in hand to purchase inputs and are bound to rely on shopkeepers to buy inputs (mostly of inferior quality) at much higher prices and interest rates. Keeping in view the results of this study, it is suggested that redistribution of land through land reforms will help achieve higher efficiency by giving land ownership to marginal and small farmers. The extension agents and agricultural economists need to educate farmers through mass media about their rational decisions by taking into account owned labor wage and land rent in decision making.

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## Competing Interests

The Authors declare that they have no competing interests regarding contents of this paper.

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