Measuring Technical Efficiency of Wheat Farms in Punjab, Pakistan: A Stochastic Frontier Analysis Approach

Muhammad Aamir Shahzad
Department of Economics, Pakistan Institute of Development Economics (PIDE), Quaid-i-Azam University Campus, Islamabad (44000), Pakistan

Amar Razzaq (Corresponding Author)
College of Economics and Management, Huazhong Agricultural University, No. 1 Shizishan Street, Hongshan District, Wuhan (430070), China.
Email: amar.razzaq@webmail.hzau.edu.cn

Muhammad Aslam, Muhammad Faisal Gulzar
School of Commerce & Accountancy, Minhaj University, Lahore (54000), Pakistan

Muhammad Asad ur Rehman Naseer
Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad (38000), Pakistan

Nimra Nisar
Department of Education, National University of Modern Languages, H-9 Islamabad (44000), Pakistan

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Abstract-
The wheat productivity in Punjab is less than the potential maximum due to imbalanced input use and farm management issues. Many studies have attempted to estimate technical efficiency of wheat crops using different techniques. However, most of them used limited datasets that focus on only a few districts. This study study uses a comprehensive dataset which is representative of Punjab province. We used farm-level panel survey data collected from 1581 farms in 17 districts of Punjab from 2005-06 to 2007-08. The technical efficiency of the wheat farms was analyzed using Stochastic Frontier Analysis (SFA) approach. Further, we identified the determinants of (in)efficiency using the same method. The results show that the mean technical efficiency of wheat farmers in Punjab is 84 percent indicating a
considerable room for efficiency improvement. Further, the results indicate that technical efficiency could be improved by educating the younger farmers, building road infrastructure, and improving farmers’ access to essential inputs. The study supports the argument that wheat farmers are less technically efficient in Punjab, Pakistan.

Keywords: technical efficiency, wheat, stochastic frontier analysis, Punjab Pakistan

1. Introduction

Wheat is the most important crop and essential diet of people in Pakistan. Wheat contributes 10.1% to value added in agriculture and 2.2% to overall GDP. It is an important source of total calorie intake and fulfills 60% of carbohydrates and protein needs for an average person. The government announces support price from time to time for wheat that induces farmers to move from conventional production practices to advanced methods of production. However, Pakistan faced a severe wheat crisis in 2007-08. Currently, there is a shortfall of 2.7 million tons due to less production in Punjab province.

Although the average Pakistani farmer uses more inputs, the productivity of the wheat crop remains lower than that of the developed countries (Ahmad et al., 2002; Byerlee, 1992). Factors such as conventional ways of farming, increases in input prices, bad quality of fundamental inputs and less use of modern technology are responsible for low production of wheat (Sher and Ahmad (2008). The constraint on land and limited water resources also cause wheat production to fall short of maximum potential production (Hassan and Ahmad (2005). Low yield also arises due to technical inefficiency which occurs when timing and application of production inputs are mismanaged (Ahmad et al. (2002); Bakhsh (2007); Hassan and Ahmad (2005).

Technical efficiency can be measured by parametric and non-parametric methods. Non-parametric methods mainly include the Data Envelopment Analysis (DEA) approach which is a deterministic approach. Some studies have used DEA in measuring efficiency in agricultural production in Pakistan (Razzaq et al., 2019; Watto & Mugera, 2015). The other approaches applied to measure efficiency are parametric techniques, which can be classified into two categories: 1) Non-Frontier approach; and 2) Frontier approach. Studies which employed a non-frontier approach to measuring the efficiency are Jamison and Moock (1984), Azhar (1991), Ahmad (2001) and Iqbal et al. (2001). The non-frontier approach is an average production function estimation technique in which the non-conventional inputs such as age, education, information, etc. are directly incorporated into the production function. This approach does not differentiate between allocative and economic efficiency and does not account for the aspect of technical efficiency.

To overcome this shortcoming, Battese and Coelli (1988), Battese (1992), Battese and Coelli (1992) and Battese and Tessema (1993) adopted a frontier approach. The frontier approach can further be classified into the deterministic and stochastic analysis. The deterministic approach was developed by Aigner and Chu (1968) that assumes an efficient frontier from a given data set and any deviation from the efficient frontier is due to technical inefficiency, but frontier may vary due to extreme observations while the stochastic frontier approach allows
statistical noise (Bravo-Ureta and Pinheiro (1993); Afriat (1972). In stochastic frontier, the
technical inefficiency is predicted in the first step and calculated in the second step by
regressing socio-economic variables and time in an equation, but it violates the basic
assumption of “independently and identically distributed technical inefficiency effects”
(Battese and Tessema (1993); Ahmad and Ahmad (1998). The studies such as Battese and
Coelli (1995), Battese et al. (1996) and Battese and Coelli (1993) estimated technical
efficiency and its determining factors in a single step in which technical inefficiency is a
function of various observable variables such as age, education, etc. Using the SFA method to
identify determinants of inefficiency is advantageous it accommodates both stochastic
frontier and technical (in)efficiency effects in a single equation, allowing hypotheses testing.
The SFA also incorporates random shocks beyond the farmer’s control that can affect output.

Different studies have been conducted for various countries to calculate technical efficiency for
the wheat crop, such as Battese and Coelli (1993), Battese and Broca (1997), Ahmad et al. (2002),
Hassan and Ahmad (2005) and Hussain et al. (2012). These studies applied stochastic frontier
model using farm level cross-sectional data on farm specific and socioeconomic variables but
dropped important physical variables of production such as land preparation cost and transportation
cost. Battese and Coelli (1993) and Battese and Broca (1997) estimated technical efficiency of
wheat farmers for selected districts of Pakistan. Ahmad et al. (2002), Hassan and Ahmad (2005), M
Ishaq Javed et al. (2009), Mohammad Ishaq Javed et al. (2011) and Sohail et al. (2012) analyzed
technical efficiency for wheat farms, but the scope of these studies was limited since they ignored
the aspect of cropping zones, since technical efficiency differs from one cropping zone to another.
Hussain et al. (2012) is the only research that studied technical efficiency for the wheat crop by
cropping zone, but this study is also limited in scope since it relied on cross-sectional data. Within
this background, this study has been designed to estimate technical efficiency of wheat farmers in
Punjab using a comprehensive dataset which represents the whole Punjab province.

2. Materials and Methods

2.1 Estimating Technical Efficiency Using Stochastic Frontier Analysis

The stochastic frontier model using panel data proposed by Battese and Coelli (1995) can be
written as:

\[ Y_{it} = \exp(\beta \ln X_{it} + V_{it} - U_{it}) \]

\[ U_{it} = \delta Z_{it} + w_{it} \]

Where,

- \( Y_{it} \) is the production of the i-th farm at t-time period;
- \( \beta \) are the parameters to be estimated;
- \( X_{it} \) are the explanatory variables of the i-th farm at t-time;
- \( V_{it} \) is a random error term independently and identically distributed iid N \( (0, \sigma_v^2) \)
- \( U_{it} \) represents the technical (in)efficiency—non-negative random variables truncated at zero
of normal distribution at the mean $\delta Z_{it}$ and variance $\sigma^2$ i.e. $N(\delta Z_{it}, \sigma^2)$

$Z_{it}$ are the explanatory variables associated with technical (in) efficiency; $\delta$ are parameters to be estimated;

$w_{it}$ is the random error term and is truncation of normal distribution at mean zero and variance $\sigma^2$ and the point of truncation is $w_{it} \geq -\delta Z_{it}$

The stochastic frontier and technical (in) efficiency models are estimated by maximum likelihood. The likelihood function is expressed in terms of variance parameters as $\sigma^2=\sigma_v^2+\sigma_u^2$ and $\gamma=\sigma_u^2/\sigma_u^2+\sigma_v^2$

The technical efficiency score of $i$-th farm at $t$th time is obtained as follow:

$$T.E_{it} = \exp (-U_{it}) = \exp (-\delta Z_{it}-w_{it})$$

One step stochastic frontier model is estimated using computer software program FRONTIER 4.1.

2.2 Empirical Specification of the Stochastic Frontier Model

The most popular functional forms used in efficiency analyses are Cobb-Douglas (CD) and Translog. Ahmad and Bravo-Ureta (1996) have shown that the major sources of variation in (in) efficiency levels across models can arise from the assumption made regarding the distribution of the one-sided term in the stochastic frontier. However, the efficiency analyses provide fairly consistent results across alternative model specifications. Following this argument and the conclusions of this study, we preferred to use CD function due to its simplicity and to avoid possible collinearity among the independent variables. The stochastic frontier model with Cobb-Douglas specification is given below:

$$\ln \text{yield} = \alpha + \beta_1 \ln \text{fym} + \beta_2 \ln \text{cpw} + \beta_3 \text{Dirrigation} + \beta_4 \ln \text{irrigation} + \beta_5 \ln \text{wheatarea} + \beta_6 \ln \text{labor} + \beta_7 \ln \text{seed} + \beta_8 \ln \text{NPK} + \beta_9 \text{Dbarrani/irrigated} + \beta_{10} \text{Year}_{it} + \text{V}_{it} - \text{U}_{it}$$

Where,

$\ln \text{yield} =$ Natural log of Wheat yield per acre in Mounds (40kg)

$\ln \text{fym} =$ Natural log of farmyard manure (FYM) for positive values of FYM-cartloads/acre otherwise zero

$\text{Dfym}^1 =$ Dummy variable representing zero for positive values of FYM and value=1 for zero values of fym

$\ln \text{cpw} =$ Natural log of the cost of pesticides and herbicides/acre for positive values and zero otherwise

________________________

$^1$The dummy variables besides their respective continuous variables are used in the model to accommodate zero observations. There are farmers who do not use manure, do not apply pesticides/herbicides, and do not have access to irrigation water etc [see (Ahmad, 2003) and (Ahmad et al., 2002)].
Dcpw= Dummy variable representing zero for positive values of cpw and value=1 for zero values of cpw

lnirrigation= Natural log of the number of irrigations per acre for positive values and zero otherwise

Dirrigation= Dummy variable representing zero for positive values of irrigation per acre and value=1 for zero values of irrigation.

lnwheatarea= Natural log of the total area under wheat crop in acres

lnlabor= Natural log of labor applied per acre in mandays

lnclp= Natural log of the cost of land preparation per acre (Rs.)

lnseed= Natural log of seed per acre in kgs

lnNPK= Natural log of fertilizer nutrients NPK per acre in kgs.

The following equation gives the technical (in) efficiency model:

\[ U_{it} = \delta_0 + \delta_1 \text{age}_{it} + \delta_2 \text{edu}_{it} + \delta_3 \text{tc}_{it} + \delta_4 \text{farmsize}_{it} + \delta_5 \text{Year}_{it}^2 \]

Where,

\text{Age}=\text{Age of the farmer in years}

\text{Edu}=\text{Education of the farmer in no. of years of schooling}

\text{TC}=\text{Total cost of transportation from farm to market (Rs.)}

\text{Farmsize}=\text{Total area of farm in acres.}

\text{Year}=\text{year of observation.}

2.3 Study Area and Data Sources

The study was conducted in Punjab, Pakistan. Punjab is the largest producer of agricultural commodities in Pakistan. There are about 5.5 million farms in Punjab which cover an area of 28.77 million acres (Naseer et al., 2016). Further, most farmers practice mixed cropping while producing crops and rearing dairy animals to meet their daily needs (Ashfaq et al., 2015a; Ashfaq et al. (2015b). Considering the importance of Punjab in Pakistan’s agricultural economy, we purposively selected this province for estimating technical efficiency of wheat farmers. The data used in this study was obtained from the Punjab Economic Research Institute (PERI), Lahore. To give appropriate coverage to all types of heterogeneous farms, PERI divided Punjab province into three regions based on the irrigation source: barrani (rainfed); partial barrani; and irrigated zones. In total, 17 districts were selected to give due coverage to all regions. These districts include Attock, Rawalpindi, and Chakwal representing the barrani areas; Bhakar and Khushab representing the partial barrani areas; and Jhang, Faisalabad, Sargodha, Okara, Hafizabad, Sheikhupura, Sialkot, D.G. Khan,

\text{Battese and Coelli (1995)}
R.Y. Khan, Vehari, Multan, and Khanewal representing the irrigated areas. Two villages were randomly selected from each district, and thus, 34 villages in 17 districts were selected. The data was collected by the interviewers of Punjab Economic Research Institute (PERI) Lahore.

The variables used to estimate the efficiency are presented in Table 1.

Table 1. Summary statistics of variables used in the analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Units</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat yield per acre</td>
<td>Mounds</td>
<td>32.60</td>
<td>8.31</td>
<td>7.5</td>
<td>53</td>
</tr>
<tr>
<td>Wheat area sown</td>
<td>Acres</td>
<td>5.63</td>
<td>7.16</td>
<td>1</td>
<td>67</td>
</tr>
<tr>
<td>Farmyard manure per acre</td>
<td>No. of cartloads</td>
<td>3.20</td>
<td>8.27</td>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>Seed rate per acre</td>
<td>Kgs</td>
<td>50.00</td>
<td>6.46</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Cost of pesticides and herbicides per acre</td>
<td>Rupees</td>
<td>310.00</td>
<td>219.78</td>
<td>0</td>
<td>960</td>
</tr>
<tr>
<td>Number of irrigations per acre</td>
<td>Numbers</td>
<td>4.30</td>
<td>2.01</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Labour applied per acre</td>
<td>Man days</td>
<td>4.50</td>
<td>1.38</td>
<td>2.65</td>
<td>9.50</td>
</tr>
<tr>
<td>Cost of land preparation per acre</td>
<td>Rupees</td>
<td>885.00</td>
<td>321.70</td>
<td>500</td>
<td>2250</td>
</tr>
<tr>
<td>NPK nutrients per acre</td>
<td>Kgs</td>
<td>333.00</td>
<td>317.68</td>
<td>30</td>
<td>1596</td>
</tr>
</tbody>
</table>

Variables in the inefficiency model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Units</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation cost</td>
<td>Rupees</td>
<td>36.00</td>
<td>260.53</td>
<td>0</td>
<td>3000</td>
</tr>
<tr>
<td>Total farm area</td>
<td>Acres</td>
<td>14.10</td>
<td>15.06</td>
<td>1</td>
<td>98</td>
</tr>
<tr>
<td>Age of the farmer</td>
<td>No. of years</td>
<td>43.50</td>
<td>13.90</td>
<td>17</td>
<td>74</td>
</tr>
<tr>
<td>Education of the farmer</td>
<td>No. of years</td>
<td>6.00</td>
<td>4.62</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

3. Results and Discussion

3.1 The Results of Stochastic Frontier Model

The maximum likelihood parameters are obtained by estimating the model using computer program FRONTIER 4.1. The results of the MLE are reported in table 2. The hypothesis of no technical efficiency is rejected because the likelihood ratio value of 389.05 is higher than the critical value of 5.14-19.04 indicating the existence of technical inefficiency on the sampled farms. Hence, the stochastic frontier production approach is preferred over the average function estimated using the OLS technique. Furthermore, the parameters of $\sigma^2$ and $\gamma$ are significant at the 1% critical level implying that average production function is not an adequate representation of the data. The results show that ten parameter estimates out of 12 are statistically significant at least at the 10% level of probability. All coefficients of the included variables carry the expected signs, except that of total labor which is negative and significant—that could be due to measurement error of allocating labor time to a specific crop, i.e. wheat in this case. Battese and Coelli (1993) found a similar result. Both coefficients of
farmyard manure, FYM, are positive and statistically significant at the 1% level. Ahmad et al. (2002), Ahmad (2003) and Hassan and Ahmad (2005) found the same results. The parameters of the cost of pesticides and herbicides are statistically non-significant. However, the cost of pesticides and herbicides have a positive association with wheat yield. The coefficient of irrigation variables is positive and statically significant at the 5% level showing the importance of irrigation water to increase wheat productivity. This result is consistent with the outcomes of Hassan and Ahmad (2005), Ahmad (2003) and Ahmad et al. (2002). Also, (Razzaq et al., 2018) found that wheat farmers in Punjab using high-efficiency irrigation systems obtained higher yields and gross margins. This implies that irrigation is an important factor influencing the productivity of wheat farms in Punjab.

The parameter of dummy variable of irrigation representing production regime of wheat with no irrigation is negative and statistically significant at the 1% level indicating significantly lower wheat productivity on the farm fields where no application of irrigation water was observed. The coefficient of wheat area is negative which implies that wheat farmers face diminishing returns to scale and the result is consistent with the results found by Ahmad et al. (2002), Bakhsh (2007) and Kumbhakar et al. (1991). The parameters of seed and cost of land preparation both have positive signs and significant at the 1% and 10% level respectively. The variable of year is negative and significant indicating that over time technical inefficiency decreases. The farmers located in irrigated regions are technically more efficient than those of Barrani regions. Finally, the parameter estimate of NPK nutrients used per acre of wheat area carries a negative sign and is insignificant. The results further show that the mean technical efficiency is estimated to be 84%, implying that the wheat production efficiency can be increased by 16% if the farmers use the existing technology more efficiently.
Table 2. The maximum likelihood estimates for Cobb-Douglas production function

<table>
<thead>
<tr>
<th>Variables</th>
<th>Parameters</th>
<th>Coefficients</th>
<th>Standard Errors</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stochastic Frontier Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>A</td>
<td>2.82***</td>
<td>0.200</td>
<td>14.1</td>
</tr>
<tr>
<td>lnFYM</td>
<td>β1</td>
<td>0.0406***</td>
<td>0.0123</td>
<td>3.30</td>
</tr>
<tr>
<td>lnCPM</td>
<td>β2</td>
<td>0.0958***</td>
<td>0.0322</td>
<td>2.97</td>
</tr>
<tr>
<td>Ddcpw</td>
<td>β4</td>
<td>0.0743</td>
<td>0.0712</td>
<td>1.04</td>
</tr>
<tr>
<td>lnIrrigation</td>
<td>β5</td>
<td>0.04182**</td>
<td>0.0204</td>
<td>2.05</td>
</tr>
<tr>
<td>DTI</td>
<td>β6</td>
<td>-0.390***</td>
<td>0.0355</td>
<td>-11.0</td>
</tr>
<tr>
<td>lnWheat area</td>
<td>β7</td>
<td>-0.001.73</td>
<td>0.00719</td>
<td>-0.241</td>
</tr>
<tr>
<td>lnCLP</td>
<td>β8</td>
<td>-0.0180</td>
<td>0.0206</td>
<td>-0.875</td>
</tr>
<tr>
<td>lnSeed</td>
<td>β9</td>
<td>0.0273*</td>
<td>0.0150</td>
<td>1.82</td>
</tr>
<tr>
<td>Year</td>
<td>β10</td>
<td>0.130***</td>
<td>0.0395</td>
<td>3.30</td>
</tr>
<tr>
<td>Year</td>
<td>β11</td>
<td>-0.00588</td>
<td>0.0740</td>
<td>-0.0794</td>
</tr>
<tr>
<td>Year</td>
<td>β12</td>
<td>-0.01.46*</td>
<td>0.00786</td>
<td>-1.85</td>
</tr>
<tr>
<td>Inefficiency model</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>δ0</td>
<td>1.00***</td>
<td>0.102</td>
<td>9.86</td>
</tr>
<tr>
<td>Age</td>
<td>δ1</td>
<td>0.000556</td>
<td>0.00143</td>
<td>0.390</td>
</tr>
<tr>
<td>Education</td>
<td>δ2</td>
<td>-0.02.35***</td>
<td>0.00642</td>
<td>-3.66</td>
</tr>
<tr>
<td>Transportation</td>
<td>δ3</td>
<td>-0.000676***</td>
<td>0.000180</td>
<td>-3.75</td>
</tr>
<tr>
<td>Farmsize</td>
<td>δ4</td>
<td>-0.00261*</td>
<td>0.00166</td>
<td>-1.58</td>
</tr>
<tr>
<td>Year</td>
<td>δ5</td>
<td>-0.911***</td>
<td>0.176</td>
<td>-5.16</td>
</tr>
<tr>
<td>Dbahrami/irrigated</td>
<td>δ6</td>
<td>-1.19***</td>
<td>0.236</td>
<td>-5.03</td>
</tr>
<tr>
<td>Variance Parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sigma-squared</td>
<td>σ2</td>
<td>0.4189***</td>
<td>0.0914</td>
<td>4.58</td>
</tr>
<tr>
<td>Gamma</td>
<td>Γ</td>
<td>0.977***</td>
<td>0.00516</td>
<td>189.00</td>
</tr>
</tbody>
</table>

log likelihood function = 389.05  LR test of the one-sided error = 340.75

Note: *, ** and *** represent the significance of variables at 10%, 5% and 1% level respectively.

3.2 SFA Estimates of Technical Efficiency

Technical efficiency measures for wheat farms are estimated using stochastic frontier analysis. The results are given in Table 3 and Table 4.

Table 3. Average Estimates of Technical Efficiency from SFA Model

<table>
<thead>
<tr>
<th>Efficiency Score</th>
<th>SFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>84</td>
</tr>
<tr>
<td>Minimum</td>
<td>26.44</td>
</tr>
<tr>
<td>Maximum</td>
<td>97.90</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>13.00</td>
</tr>
</tbody>
</table>
Table 4. Frequency distribution of technical efficiency estimates from SFA model

<table>
<thead>
<tr>
<th>Range of TE</th>
<th>No. of farms</th>
<th>% of farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>65</td>
<td>4.11</td>
</tr>
<tr>
<td>50-60</td>
<td>41</td>
<td>2.59</td>
</tr>
<tr>
<td>60-70</td>
<td>103</td>
<td>6.51</td>
</tr>
<tr>
<td>70-80</td>
<td>256</td>
<td>16.19</td>
</tr>
<tr>
<td>80-90</td>
<td>495</td>
<td>31.30</td>
</tr>
<tr>
<td>90-100</td>
<td>621</td>
<td>39.30</td>
</tr>
<tr>
<td>Total</td>
<td>1581</td>
<td>100</td>
</tr>
</tbody>
</table>

3.3 Analysis of the Determinants of Farm Level Inefficiency

The SFA measures the technical (in)efficiency estimates and their determinants simultaneously in a single step. The technical (in) efficiency results of the SFA approach are provided in Table 5.

The estimated coefficient of age is positive, though insignificant in the SFA model. This result implies that younger farmers are technically more efficient than the older farmers because older farmers are rigid in the adoption of new technologies and younger have more adaptability to modern production practices.

The impact of education on technical inefficiency is negative. This indicates that educated farmers are more technically efficient than illiterate farmers.

The parameter of farm size is negative and statistically significant at 10% in the SFA model. This implies that large farmers are technically more efficient than small farmers—small farmers are less resourceful and having poor access to advanced technology and quality inputs.

The transportation cost parameter is negative and significant in the SFA model. This indicates that technical efficiency increases when the transportation cost increases. Ahmad et al. (2000) argued that the farmers who try to purchase superior quality inputs even from distant markets and rely less on village dealers have to bear the high cost of transportation. The use of better-quality inputs would naturally result in higher productivity than those farmers who relied on village dealers for their inputs. Moreover, even marketing their produce in grain markets rather than selling to the village dealers can fetch them a better price. Therefore, it is more likely that such farmers would be more technically efficient. The inefficiency is decreasing with the passage of time.

The technical efficiency estimates of wheat production in Punjab are very low. Van Tran (2001) argued that the low technical efficiency at the farm level is associated with resource management and cultural factors. These factors are categorized into socio-economic and
biological factors. The socio-economic factors include farmer’s age, education, farm area, and the transportation cost. However, biological factor includes, the seed rate, area cultivated, irrigation applied, labor used, and pesticides and fertilizers applied. Lastly, the technical efficiency estimates are also affected by the government policy which affect input/output prices, irrigation availability, fertilizer and pesticides resource management and the availability of technical information. These factors are important determinants of wheat productivity.

Table 4. Factors affecting technical (in)efficiency of wheat farms

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.00***</td>
</tr>
<tr>
<td>Age</td>
<td>0.000556</td>
</tr>
<tr>
<td>Education</td>
<td>-0.0235***</td>
</tr>
<tr>
<td>Transportation</td>
<td>-0.000676***</td>
</tr>
<tr>
<td>Farm size</td>
<td>-0.00261*</td>
</tr>
<tr>
<td>Year</td>
<td>-0.911***</td>
</tr>
<tr>
<td>Dbarrani/irrigated</td>
<td>-1.19***</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>380.4134</td>
</tr>
</tbody>
</table>

Note: *, ** and *** represent the significance of variables at 10%, 5% and 1% level respectively.


The major objective of the study was to estimate the technical efficiency of wheat farms using SFA analysis techniques. The data was obtained from Punjab Economic Research Institute (PERI), Lahore. The data consists of 1581 wheat farms during the period 2006-2008, and it contains information regarding input use and production costs for the wheat crop. The average technical efficiency estimated through SFA was 84 percent. The analysis implies that technical efficiency can be increased by 16 percent while using the same level on inputs. The results of SFA show that the education, transportation cost, farm size, year and regional factors have a positive impact on technical efficiency. The study supports the argument that the wheat farmers are in Punjab are not fully technically efficient, and wheat production can be increased by increasing efficiency.

Based on the results of this study, we recommend the following policy options to improve the productivity and efficiency of wheat farmers in Punjab. First, the parameters of SFA model show that the productivity is influenced by the inputs like farmyard manure, labor, and the seed. Therefore, the policymakers should pay attention to educate the farmers on the balanced use of these inputs. Second, irrigation water availability increases the crop productivity so canal water should be available during the required time. Water deficiency can be fulfilled by making the arrangements of popularizing the rain harvesting technology and by reducing the canal water loses either via canal lining or water-course lining. Third, the agricultural extension service plan should be designed to be held at the beginning of the season. Agricultural extension agents should arrange training programs to inform farmers about crop production techniques. Further, the wheat extension programs should be developed to equip the farmers with modern technology and knowledge of methods of production.
References


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