# Exploring the determinants of technical inefficiency in mango enterprise: a case of Muzafargarh, Pakistan

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## Abstract

The study purpose is parametric estimation of technical efficiency level of mango growers and exploring those socio management factors responsible for inefficiency in mango production. A Cobb Douglas production function was applied by stochastic frontier analysis. Maximum likelihood was used to check the source of variation in mango yield. Empirical inefficiency model has been developed. Total 110 randomly selected mango growers were personally interviewed by well-designed questionnaire. Results of maximum likelihood shows, 99 percent variation from potential yield level was attributed by technical inefficiency. In result of Cobb Douglas function, the average efficiency level of mango growers was 0.60. It implies that still mango growers have opportunity of reducing the inputs usage by 40 percent without compromising the mango yield. The age of respondents, age of orchard, orchard size and intercropping were contributing in inefficiency of mango growers. On other hand Schooling years, family size, orchard experience, owned power source and access to extension were significantly reducing the inefficiency level. The efficient farmers' social profile was much better than moderate and inefficient farmers. The technical efficiency can be increased by providing the better understanding of mango growing technology through extension services in the study area.

**Keywords:** Technical Inefficiency, Mango Growers, Determinants

## 1. Introduction

Agriculture is the backbone of Pakistan's economy due its major share (19.8 percent) in gross domestic product. Agriculture sector is also very important because it absorbs 42.3 percent of total labour force of Pakistan (GoP, 2016). Horticulture as sub sector of agriculture has secured its position in uplifting the Pakistan economy. The diversity in the Pakistan's climate allows the cultivation of almost all types of fruits and nearly 144 different types of fresh and dry fruits are eaten and sold in country (Khan and Shaukat, 2006). So horticulture in Pakistan can be considered to provide an opportunity for improving the socio economic conditions of residents of rural areas (Alam and Mujtaba, 2002). Mango is considered one of the most delicious fruit in all over the world due to its taste, flavour and nutritious value. Mango is called king of Fruits in country (Balal et al., 2012).

Internationally, Pakistan falls at 4th position in production of mango after India, China and Thailand (Anonymous, 2016). Mango is cultivated in more than hundred countries all over the world (ICCI, 2010). In Pakistan, mango is second largest growing fruit after citrus. Large mango cultivated areas are in Sindh and Punjab provinces. In Punjab the most productive districts are Multan, Muzaffargarh, Bahwalpur and Rahim Yar khan (TRTA, 2010). The last year total production of mango was 1636 thousand tonnes (GoP, 2016). Per hector production (10.62 tons) of mango was much better than average of the world (7.51 tons). Pakistan has potential in mango enterprise to enhance production higher than 15 tons per hector (GOI. 2013).

Yellow skinned, soft and delicious Pakistan mango is a nutritionally filled and good source of minerals and vitamins. Mango is being cultivated at farm size which ranges from less than two hectors to hundreds of hectors. Unfortunately, mango industry of Pakistan is not fully developed. The most poorly developed production harvesting and marketing systems and uneven distribution of return supressed the mango industry of Pakistan. Poor facilities such as absence of cold storage according the desired demand, grading facilities, late harvesting and poor transport means are also other obstacles in the way of mango industry to flourish. The mango growers do not take care of mango crop and sell their fruit to contractors (TRTA, 2010).

Except theses above mentioned problems that exist in mango enterprise, other many farm level problems are also responsible for low yield of mango in country. Many studies encountered the factors responsible for yield gap of mango in Pakistan. The presence of infected mango trees and poor management practices would lead to the destruction of orchard (Saeed et al., 2012). Mohsin et al. (2014) explained that the pest diseases and improper management can be a source of sever problems. In same study they said majority of mango growers do not follow the recommended techniques for effective use of pesticides, irrigation and fertilizer. Many responsible factors are studied in many studies but it had realized the flaw in assessment of mango grower's efficiency level. One of the reasons of low yields of mango production could be technical efficiency level of growers. To improve the technical efficiency and productivity of mango growers, the factors which contribute in technical inefficiencies should be known. **Objectives of study**

More specifically this study is planned to focus on estimating the technical efficiency of mango growers and determining the factors that are contributing in technical inefficiencies of mango growers. So the general objective of the study are defined as

- To assess the descriptive characteristics of the mango growers
- To estimate the efficiency level of mango growers
- To assess the socio management factors influencing the inefficiency of mango growers.
- To develop recommendations on the basis of study results

## 2. Materials and Methods

This study is confined to the district Muzaffargarh. This district has major share in mango production in Punjab province that is why it has prime importance in total mango production. It is situated in southern west of Punjab Pakistan on the bank of river Chenab. Its total area is 8,249 km2.

First, one tehsil of Muzafargarh out of four tehsils were selected. From that tehsil 4 union councils were selected randomly. The data was collected from 110 mango growers selected through simple random sampling. The well-designed questionnaire was constructed to get information about the variables that were considered necessary to complete this study. The quantity and price information of yield and inputs used in one year were collected. Dollar conversion was performed by using the exchange rate (1 $ =104.87 PRs.) and all monetary values were presented into dollar. The gross income was estimated by multiplying the yield of mango with per kilogram of mango. The working capital was estimated by aggregating the all expenses made on fertilizer, irrigation, pesticides, hired labour etc.

We could use either data envelopment analysis or stochastic frontier analysis. The data envelopment analysis has a drawback as it is unable to consider the variability in agriculture and accuracy of data collected during interviews from farmers in real world. The stochastic frontier analysis has benefits over it in estimation the frontier function by taking into account the random shocks and inefficiency component. Data envelopment analysis just assuming all deviation is just due to inefficiencies (Bravo-Ureta and Pinheiro, 1997). Sarafidis (2002) said that stochastic frontier analysis is a parametric model which uses econometric functions. He said that this analysis particularly separates the two type components one error and second is inefficiency. Similarly, a non-negative inefficiency term $U_i$ and random error term $V_i$ is allowed to estimate by this analysis (Kumbhakar and Lovell, 2000). These supporting arguments about stochastic frontier analysis (SFA) help to complete this estimation of technical efficiency level of mango growers.

## 3. Theoretical Framework

Farrell (1957) said that farmers obtaining maximum output with given level of inputs are technically efficient farmers. Similar concept of technical efficiency has been applied by Haq *et al*., (2016) in study conducted in Faisalabad. Ability of two different farmers is possible to be different. Two farmers using same input level with same technology, their output level can be different from each other. Here two situations can be reasons of different output level, as difference may be random variation and second attributes related to the individual important basic characteristics that can be affected through national policies (Ali, 1996). There are two ways by which technical efficiency can be measured such as input oriented and output oriented.

Technical efficiency in not an absolute concept rather it is a relative concept. It shows the output level of the $i^{th}$ farmer relative to the efficient farmer's output level produced by using same set of inputs. The efficient best production frontier is considered as stochastic which consider two sided error term with the intention of exogenous variables that are not under control of farmers. Frontier output level is not possible to produce by all farmers, so that additional error term is familiarized to signify technical efficiency. Aigner and Chu (1968) suggested Cobb-Douglas production function to estimate the parametric frontier production function. This function is presented in equation 1.

$$Ln(Y_i)= X_i \beta - U_i \quad i = 1,2,3,\ldots\ldots..n$$

Output of mango of i-th farmer is $Y_i$. Input vector (K+1) is denoted by $X_i$ of which first element is one and all remaining elements are the logarithm of the K inputs' quantities. β,s are unknown parameter to estimate. $U_i$ is random variable regarding technical inefficiency of the mango growers.

So technical efficiency of the mango growers is estimated by taking ratio of observed output of the i-th farmer and the output at frontier at certain input level (Coelli *et al*, 1998). So empirical dimension of technical efficiency (TE) is

$$TE = Y_i / \exp (X_i \beta) = \exp (X_i \beta - U_i) / \exp (X_i \beta) = \exp (-U_i)$$

$Y_i$ shows the observed output of i-th mango grower and $Y_i^*$ is frontier output of i-th mango farmer. The estimated score of Technical efficiency (TE) varies between 0 and 1. Close to 1 means the farmer is fully efficient obtaining the output equal to the frontier output. This frontier model is proposed by Battese and Coelli (1995) which has resemblance with original model defined by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977). In this study similar model was used to assess the efficiency score of mango growers. In general the stochastic frontier model is presented in equation below

$$LnY_i= f (X_i \beta) +V_i- U_i$$

$Y_i$ is observed output of $i^{th}$ mango farmer and $Y_i^*$ is frontier output of $i^{th}$ mango farmer. Here $V_i$ is random factors shows the factors those are not under control like effects of flood, strikes and weather etc. and $U_i$ expressed the inefficiency of mango growers. Aigner *et al*. (1977)

assumed the $V_i$ is identical and independent random variables with zero mean and constant variance. Second error term $U_i$ is considered as absolute value of normal distribution.

## 4. Empirical Models

The Frontier program 4.1designed by Coelli (1994) was used to conduct this procedure of estimations. The Maximum Likelihood (ML) method is applied to estimate the parameters of SFA. Production function and the inefficiency model are two parts that are considered by SFA. The first empirical form of production frontier is given below

$$\text{Ln Y} = \beta_o + \sum_{i=1}^{6} \beta_o \text{ Ln} X_i + V - U$$

Where Y is mango output per acre, $X_i$ is an inputs quantities' vector and β, s are unknown parameters to assess.

Ln (Yield of Mango) = βo + β1 Ln (Quantity of Nitrogen) + β2 Ln (Quantity of Phosphorus) + β3 Ln (Quantity of Potash) + β4 Ln (Number of Insecticides) + β5 Ln (Number of Irrigation) + β6 Ln (Working Capital)

Many socio economic factors are included in inefficiency Model which is specified as

$$U_i = \alpha_o + \sum_{i=1}^{9} \alpha_i \; Z_i$$

The most commonly used explanatory variables in earlier studies completed globally to emphasize the efficiency of the sampled respondents were age of respondent, their experience, schooling years, gender, family size, extension access, off-farm income, credit facility, orchard age, market access, farm age and organization membership (Wilson *et al*., 2001, Trip *et al*., 2002, Iraizoz *et al*., 2003, Kyei *et al* 2011, Deme *et al*., 2015, Karani-Gichimu *et al*., 2015, and Abdul-Rahaman, 2016.

$U_i = \alpha_o + \alpha_1$ Age of Respondents + $\alpha_2$ Schooling Years + $\alpha_3$ Family Size + $\alpha_4$ Orchard Experience + $\alpha_5$ Age of Orchard + $\alpha_6$ Orchard Size + $\alpha_7$ Owned Power Source + $\alpha_8$ Practicing Intercropping + $\alpha_9$ Access to Extension

In this study nine explanatory variables were considered to affect the efficiency of mango growers. Ownership of asset (power source), farmer's practice of intercropping were also taken as new variable that were not used in the previously mentioned studies. Information about each variable was collected through the questionnaire. The dummy variable for owned power source was used, 1 if farmer has own power source otherwise 0. Second dummy variable was practice of intercropping, 1 for farmer who was cultivating Rabi and kharif crops in orchard otherwise 0. Access to extension of farmers was third dummy variable, 1 for farmer who took advice from extension agent otherwise zero.

To test the hypothesis that young farmers are more efficient than older this may be implies that the younger are more innovative. Because low education level and lack of experience were contributed into inefficiency, the schooling year and experience of the mango growers (Years) were considered also into the model.

## 5. Variance Parameters of random error terms, hypothesis and categorization

Variance of error term $V_i$ denoted as $S_v^2$ and variance related to $U_i$ is denoted as $S_u^2$. Aigner *et al.* (1977) suggested two variance parameters are given below related to the SF model.

$$S^2 = S_u^2 + S_v^2$$

Other variance ratio is suggested by Battses and Corra (1977)

$$\gamma = S_u^2 / S^2$$

$\gamma$ lies into 0 and one. If its value is zero than it means that the deviation from frontier is totally due to noise while 1 indicates the deviation is entirely due to inefficiency.

The null hypothesis was tested through proposed likelihood ratio test by (Coelli *et al*, 1998). SF model has not technical efficiency's effect was tested by considering null hypothesis as $H_o$; $\gamma = 0$ and $H_1$; $\gamma > 0$

$$LR = -2 \{\ln[L(H_o)/L(H_1)]\}$$

Here L ($H_o$) and L ($H_1$) are value of Maximum Likelihood functions under null ($H_o$) and alternative hypothesis ($H_1$). If LR exceeds the Critical chi-square value than reject the $H_o$ hypothesis and accept the $H_1$; $\gamma > 0$.

After estimation of efficiency scores the mango growers were divided into three groups with low, moderate and high efficiency level. For this study the average value was considered as normal efficiency score. In which following formula was adopted to categorize the farmers.

$$\text{Mean TE Score} \pm \text{Standard Deviation}$$

Inefficient Group consisted of those farmers having efficiency score less than the mean score minus standard deviation. In Efficient Group, farmers having efficiency score greater than mean score plus standard deviation. Out of these two groups were categorized into third group named as moderate efficient farmers.

## 6. Results and Discussion

### 6.1. Demographic characteristics of mango growers; Descriptive Statistics

Some basic characteristics of the farmers were given in table 1. The average age of the respondents was 43.81 years. The average education level of the sampled farmers was almost 8 years. The large family size was observed in the households of the farmers. The mango growers had high experience in mango growing. The average age of mango orchard was 25.78 years which is lower than normal economic bearing life that is 30 to 50 years (PAR, 2015). Per acre number of plants of mango was almost 38. These 38 plants per acre were giving the yield 11818.27 Kg. from it farmers were earning the gross income of $743.08 after investing total capital value of $370.02 per acre. The average area devoted to the orchard by the farmers in area was 6.41acre which was 33.80 percent of the farm size.

**Table.1: Basic characteristics of mango growers; Descriptive Statistics**

| | | 95%CI | |
|---|---|---|---|
| Variables | M(SD) | LL | UL |
| Age (Years) | 43.81(14.64) | 21.00 | 83.00 |
| Schooling years | 8.05(5.37) | 0.00 | 16.00 |
| Family Size | 9.33(4.46) | 3.00 | 27.00 |
| Orchard Experience (Years) | 19.27(9.54) | 3.00 | 51.00 |
| Age of Orchard (Years) | 25.78(8.37) | 5.00 | 45.00 |
| Orchard Size (Acres) | 6.41(6.83) | 1.00 | 30.00 |
| Number of Plants per Acre | 38.14(9.30) | 16.00 | 60.00 |
| Yield/acre (kg) | 1818.27(630.08) | 653.44 | 3500.58 |
| working capital per acre ($) | 370.02(101.66) | 182.16 | 672.39 |
| Gross Income ($) per acre | 743.08(257.50) | 267.05 | 1430.62 |

Note. CI=confidence; SD = Standard Deviation; M = Mean Value LL=lower limit, UL=upper limit.

### 6.2. Results of Stochastic Frontier Analysis

This section presents the results of Cobb-Douglas production function estimates. This discussion includes the estimated parameters of inputs utilized in the mango production. Model variance and gamma were also presented. The cobb-Douglas parameters estimated by maximum likelihood method are shown in table 2.

All coefficients of the model's parameters were positive except phosphorus. It means all parameters having positive coefficients have increasing effect on the yield of mango. The nitrogen, potash and working capital were found statistically significant (p <0.01). The negative impact of phosphorus explained that increasing amount of phosphorus will decrease the yield of mango, but relationship was statistically insignificant. It implies that the quantity of phosphorus should be reduced. Other two parameters insecticides and number of irrigation had positive effect but their effect on yield was also insignificant.

Results about variance parameters were also presented in table. The estimated significant value of the variance parameters indicate there was an impact of technical efficiency on the mango yield and also suggested that the conventional OLS model was not the appropriate to represent data. The variance parameter gamma also was significantly different from 0 at 1 % level of significance. Its value measured by the standard error ratio was close to one that was 0.99 which indicates deviation from frontier is entirely due to inefficiencies. It means 99 percent variation in mango yield is ascribed to technical inefficiency. In addition, the LR test was used for testing the null hypothesis which was Gamma equal to zero indicates that Stochastic model has no inefficiency effect. Based on the value of LR test that shows the strongly rejection of null hypothesis.

**Table.2: Maximum Likelihood estimates of Cobb-Douglas Stochastic Frontier Model**

| Variables | Parameters (β,s) | Coefficient | Std. Error | t-ratio | P-values |
|---|---|---|---|---|---|
| Constant | βo | 6.03 | 0.27 | 22.00 | 0.00 |
| Ln (Quantity of Nitrogen) | β1 | 0.09 | 0.01 | 6.31 | 0.00 |
| Ln (Quantity of Phosphorus) | β2 | -0.01 | 0.02 | -0.25 | 0.80 |
| Ln (Quantity of Potash) | β3 | 0.04 | 0.01 | 5.46 | 0.00 |
| Ln (Number of Insecticides) | β4 | 0.02 | 0.02 | 1.16 | 0.25 |
| Ln (Number of Irrigation) | β5 | 0.07 | 0.07 | 1.06 | 0.29 |
| Ln (Working Capital | β6 | 0.15 | 0.03 | 5.79 | 0.00 |
| **Statistics** | | | | | |
| Sigma Squared | $S_u^2 + S_v^2$ | 0.02 | 0.00 | 7.35 | 0.000 |
| Gamma | $S_u^2 / S^2$ | 0.99 | 0.00 | 663.17 | 0.000 |
| LR Function | | 61.320 | | | |
| LR Test | | 158.320 | | | |

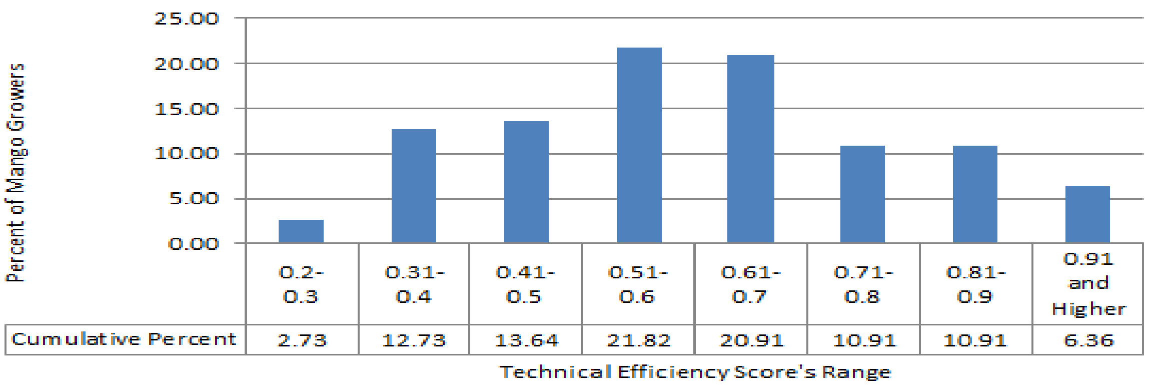


**Figure 1: distribution of technical efficiency score of mango Growers.**

The technical efficiency score of sampled farmers were varied from 0.24 to 1. The 0.60 mean efficiency score of mango growers shows considerable inefficiency in the mango growers. It means the mango growers could reduce their inputs by 40 present without reducing the mango yield. So that improving efficiency of mango growers can reduce the growing cost and enhance the gross income of mango growers. The percentage of mango growers according their technical efficiency score range was presented in figure 1. Almost fifty percent mango growers were having efficiency score less than the average efficiency score. About 17.27 percent growers were in the high efficiency score range (greater than 80 %). High proportion of mango growers (21.82 %) was in efficiency score range 0.51-0.60.

### 6.3. Technical inefficiency Model

This part of study explains the analysis of technical inefficiency. The parameters and the coefficients value were presented in table 3. The signs of the coefficients were as expectations. The significant effect was studied of seven variables out of nine like age of respondents, education of respondent, family size, orchard experience, owned capital, practicing intercropping and access to extension. The positive effect of age on technical inefficiency proved that the younger people are more efficient in mango growing due to their potential toward innovation adoption and their broad vision. This result was found similar those of Bozoğlu and Ceyhan (2007) and Kyei *et al* (2011). The high level of education reducing the inefficiency of the mango growers this may be due to education make them able to read the material and understand the inputs application and recommended management practices related to mango crop. Education can increase the ability of growers to improve their managerial skills. This finding is also similar to the results of Kebede (2001) and Oladeebo and Fajuyigbe (2007).

The negative impact of family size on inefficiency was observed this implies that the high number of family members may reduce the inefficiency due to availability of family labour at time. Abdul-Rahaman, 2016 and Fesessu (2008) also notified negative relationship of education and family size with inefficiency. Deme *et al* (2015) also assessed negative relation between family size and inefficiencies. The significant effect of orchard experience also had negative effect on inefficiency this is because of higher experience make the growers perfect in using the inputs in proportion of the output obtained over the last years.

The age of orchard had positive impact over inefficiency but insignificant, similarly orchard size also has positive insignificant effect on inefficiency. Opposite result was estimated by Karani-Gichimu *et al* (2015) about orchard age and inefficiency. The negative parameter of owned power source implies that the owned assets facilitate the cultivation practices. Farmers with owned power source have facility to manage their orchards efficiently. The positive and significant effect of intercropping practice was found on inefficiency. It may be due to division of attention of mango growers on field crops that reduce the ability of farmers to handle orchard attentively. The effect of access to extension was negative and significant on inefficiencies of mango growers.

**Table 3: Technical Inefficiency Analysis**

| Variables | Parameters (α,s) | Coefficient | Std. Error | t-ratio | p-Values |
|---|---|---|---|---|---|
| Constant | αo | 0.43 | 0.18 | 2.39 | 0.02 |
| Age of Respondents | α1 | 0.19 | 0.06 | 3.32 | 0.00 |
| Schooling Years | α2 | -0.10 | 0.01 | -6.56 | 0.00 |
| Family Size | α3 | -0.05 | 0.03 | -1.98 | 0.05 |
| Orchard Experience | α4 | -0.12 | 0.03 | -3.49 | 0.00 |
| Age of Orchard | α5 | 0.01 | 0.02 | 0.43 | 0.67 |
| Orchard Size | α6 | 0.03 | 0.02 | 1.45 | 0.15 |
| Owned Power source | α7 | -0.15 | 0.02 | -6.55 | 0.00 |
| Practicing Intercropping | α8 | 0.16 | 0.04 | 3.58 | 0.00 |
| Access to Extension | α9 | -0.19 | 0.07 | -2.66 | 0.01 |

### 6.4. Production Elasticity and return to Scale

The estimated elasticity of independent variables was explained in the table 4. The elasticity estimates of nitrogen, Potash, insecticides, irrigation and working capital was found positive decreasing function. It implies that the allocation of these variables was economically viable stage of production function. (Stage II). However, the negatively decreasing and insignificant function were observed from the production elasticity of phosphorus. It explains the over use of that input and in stage III. The aggregation of all production elasticity gave the value of return to scale. It is equal to 0.37 which indicated farmers operating in production stage II. So we can conclude that simultaneously marginal rise in all inputs by 1 % can result in 37 % increase in mango yield.

**Table 4: Production Elasticity and Return to Scale.**

| Variables | Production Elasticity and Return to Scale |
|---|---|
| Quantity of Nitrogen | 0.09 |
| Quantity of Phosphorus | -0.01 |
| Quantity of Potash | 0.04 |
| Number of Insecticides | 0.02 |
| Number of Irrigation | 0.07 |
| Working Capital | 0.15 |
| **Return to scale** | **0.37** |

### 6.5. Categorization of Mango Growers with Technical Efficiency

The results related to frequency and percentage of mango growers based on efficiency scores were presented into table 5. This table indicates high percentage of farmers (65.5 %) belongs to the moderate group. In inefficient and efficient farmers were 18 and 20 in numbers, which was 16.4 and 18.2 percent of the total sampled farmers.

**Table 5: Frequency Distribution of Mango Growers Based on Efficiency Level.**

| Categories of Farmers | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| Inefficient Framers | 18.0 | 16.4 | 16.4 |
| Moderate Framers | 72.0 | 65.5 | 81.8 |
| Efficiency Farmers | 20.0 | 18.2 | 100.0 |

The average score of technical efficiency of each group was given in table 6. The average efficient score of inefficient farmers was 0.34 means inefficient farmers can reduces inputs by 66 percent without compromising the output level. The 0.59 score of moderate group can also decrease inputs' quantity by 41 percent. The efficient farmers can also lower inputs by 13 percent without changing the output level.

**Table 6: Average Efficiency Scores of Mango Growers' Groups**

| **Categories of Farmers** | Minimum | Maximum | Mean* | Std. Deviation | F-Value |
|---|---|---|---|---|---|
| Inefficient Framers | 0.24 | 0.41 | 0.34 | 0.24 | |
| Moderate Framers | 0.43 | 0.77 | 0.59 | 0.43 | 175.46 |
| Efficiency Farmers | 0.79 | 1.00 | 0.87 | 0.79 | |

*indicates variable is statistically significant different cross the categories at 1%.

Table 7 shows the some basic characteristics of the inefficient, moderate and efficient mango growers. The efficient farmers were found young (27 Years) as compare to other groups and age variable were statistically significant across the groups at 1 %. The average schooling years of efficient mango farmers was almost 11 years which was high and significantly different than other categories of farmers' schooling years. The highest family size was observed at inefficient farms (almost 10 members). Orchard experience (19.25 years) was also high at efficient farm than others. The efficient farmers were devoting 5.85 acres to orchard which was not higher than moderate farms. The efficient farm were having orchard of low age. The highest number of plants of mango (almost 45 trees) was at efficient farms while at moderate and inefficient farms trees were almost 30 and 38 in numbers respectively. The efficient farms were investing almost US $380.08 and getting $ 1088.22 as gross income from 2662.78 kg mango yield.

**Table 7: Characteristics of Inefficient, Moderate and Efficiency Farmers**

| **Variables** | **Inefficient Framers** | **Moderate Farmers** | **Efficiency Farmers** | **p-value** |
|---|---|---|---|---|
| Age(years) | 48.94 | 47.14 | 27.20 | 0.00 |
| Schooling years | 2.50 | 8.65 | 10.85 | 0.00 |
| Family Size | 9.67 | 9.25 | 9.00 | 0.94 |
| Orchard Experience (Years) | 16.67 | 19.93 | 19.25 | 0.44 |
| Age of Orchard (Years) | 25.61 | 26.63 | 22.90 | 0.21 |
| Orchard Size (Acres) | 5.11 | 6.89 | 5.85 | 0.57 |
| Number of Plants per acre | 29.78 | 38.18 | 45.50 | 0.00 |

| | | | | |
|---|---|---|---|---|
| Yield per Acre (kg) | 957.47 | 1798.88 | 2662.78 | 0.00 |
| Working capital per acre ($) | 314.95 | 380.99 | 380.08 | 0.04 |
| Gross income ($) | 391.30 | 735.164 | 1088.22 | 0.00 |

## 7. Conclusion and Recommendations

Mango is second largest growing fruit in Pakistan after citrus. Pest diseases, infected mango trees and poor management are responsible for low mango yield in Pakistan. Poor technical efficiency of mango growers was considered as one of the important reason of low mango yield. So this study was planned to analyse the technical efficiency level of mango growers and exploring determinants of inefficiency.

Technical efficiency indices for 110 mango growers in Muzaffargarh district was calculated by using stochastic frontier analysis. The average age of sampled farmers was almost 44 years and their education level was Middle. They were spending US$ 370.02 and earning US $ 743.08 per acre. The average mango yield was 1818.27 kg.

The 99 percent variation in mango yield is attributed to technical inefficiency. The technical efficiency score of mango growers fluctuated from 0.24 to 1 while average score was 0.60. It implies that almost 60 percent of potential mango yield was achieved utilising the available resources and farm inputs. Technical efficiency level of 50 percent sampled mango growers was very low, only 17.27 percent farmers were having high efficiency score.

Farm level variables were included into the inefficiency model to explore its determinants. Schooling years, family size, orchard experience, owned power source and access to extension affected technical efficiency positively while influence of age, age of orchard, orchard size and practice of intercropping was negative on technical efficiency. The demographic characteristics of efficient farms were much better than other inefficient farms. They were better in education, had good orchard experience and younger in age. They were getting good yield level and enjoying high gross margin per acre as compare to other farms.

In the light of study results about technical efficiency, it looks considerable amount of output can be increased with same use of inputs and the prevailing technology on mango farms. Under this scenario the possible policy recommendations that policy maker should take into account (i) there is a need to enhance the access of mango growers to technical information. It could be achieved by enhancing good extension services in study area via training programs (ii) enhancing the education level in area to reduce the technical inefficiency of farmers.

The old farmers required training to improve their knowledge of new recommended technology. For this extension services in form of farmers training programs should focus on the disease control methods, use of inputs, cultivation practices of mango crop and cooperation between growers. The ownership of owned capital could be increased if credit facility at low interest level will be provided. For this loan schemes should be started at easy conditions and at low processing cost in study area. In short there is need of extension to consider the human resource development. Farmers should be realized about low yield due to intercropping in orchard that divides the attention of farmers toward crops. At this stage the development of human resources in area should be at high priority of extension agents and organizations working in study area. They agriculturist officer in area should direct the mango growers to transform their farms to market oriented. Farmers should be taught about the technical issues related to economic orchard age, orchard size and technical issues. Public investment is required to invest in infrastructure such as communication, schools and roads that may share in improving education level of mango growers.

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