ROLE OF CREDIT TO ENHANCE COTTON PRODUCTION IN PUNJAB, PAKISAN

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The study attempted to investigate the role of credit in cotton production by developing a relationship between credit and technical efficiency. The study also explores the sources of technical inefficiency by farm size groups by employing the stochastic frontier production function approach. It employed cross-section survey data of 120 farmers collected from District Muzaffar Garh. The results indicated that all three farm size categories have almost the same level of technical efficiency with slightly higher level of technical efficiency at middle farm size category followed by small and large farms. However, per acreage cost of production is found to be directly proportion to farm size implying that lowest cost of production is observed at small farms followed by middle and large farms. The major contribution of our study is, small farmer should be focused to provide credit facilities with the binding constraints that the credit should be invested to purchase tractor or to install tub wells because our results clearly depicts that availability of credit, source of power and location of farm at water course are affecting the technical efficiency of small farmers in cotton production more rigorously and with higher level of significance compared to other two farm size categories.
Keywords: Farm size, cotton, credit, technical efficiency, power source, water course

INTRODUCTION

The importance of cotton in the national economy needs no emphasis as it accounts for 10.5 percent of the value added in agriculture and about 2.4 percent in GDP (Govt. of Pakistan, 2005). Besides earning a substantial foreign exchange of over 68 percent from the export of raw cotton and value added products, it provides bread and butter to millions of people by generating opportunities of employment to large proportion of labor involved in agriculture industry of the country. It is therefore, imperative to produce maximum and best quality cotton. Pakistan has comparative advantage over the world in cotton production due to its specific climatic condition and availability of cheap labor force for the cultivation of cotton and also for ginning and textile industries.

Profitability directly or indirectly depends on resource use efficiency therefore; like in other crops technical efficiency is an important issue in cotton production. Several recent studies on the technical and economic efficiencies of crop production, particularly for wheat and rice, have pointed out the existence of a 'yield gap'. This 'gap' refers to the difference in productivity on 'best practice' and on other farms operating with comparable resource endowments under similar circumstances (Kebede, 2001.Wadud, 1999.Villano, 2005). Many studies have shown that inefficiency is the rule rather than the exception (Battese, 1992). This finding is important because the main consequence of technical inefficiency is to raise production costs, making farms less competitive.

A number of studies have analyzed the relationship between efficiency/productivity and farms size in different crops (Johnson and Ruttan, 1994., Barrett, 1998., Carter and Wiebe, 1990). The major objective of these studies was to analyze the impact of land reforms on technical efficiency by linking the issue of technical efficiency with farm size.

Government of Pakistan reserved about Rs. 14004 million in 2005 to support the agriculture sector in terms of credit (Govt. Pakistan, 2006). Earlier literature is providing evidences that availability of credit play a significant role to improve the productivity in agriculture sector and to alleviate poverty in rural areas (DFID, 2005). By keeping this in view we are attempting to relate farm size efficiency with resource endowments which will help policy managers to decide where the credit could be allocated more efficiently in future to enhance its marginal contribution. The primary objective of this study is to provide empirical evidence that how the availability of such credit could be used more efficiently and at what farm size category it could play more crucial role to improve the cotton productivity. So that a particular farm size group could be focused to boost the productivity through credit supply.

The scheme of the paper is as follows. The second section delineates the empirical model and data collection procedure. The third section presents empirical results and discusses their implications. Last section derived conclusion and policy suggestions.

Empirical Model and Data Collection Procedure

Technical Efficiency can be defined as the ability of a decision-making unit (e.g. a farm) to produce maximum output given a set of inputs and technology. Although, technical efficiency (TE) can be estimated by employing different approaches and these includes, stochastic frontier (parametric approach) and data envelopment analysis (DEA), also named as non-parametric approach. These two methods have a range of strengths and weaknesses which may influence the choice of methods in particular application and the constraints, advantages and disadvantages of each approach has been discussed by Coelli (1996); Coelli and Perelman (1999). However, it is well documented that DEA approach works under the assumption of absence of random shocks in the data set. Since, farmers always operate under uncertainty and therefore, present study is employing a stochastic production frontier approach introduced by Aigner *et al* (1977); and Meeusen and van den Broeck (1977). Following their specification, the stochastic production frontier can be written as,

$$y_i = F\left(x_i, \beta\right) e^{\varepsilon i} \quad i = 1,2,....N \qquad (1)$$

Where, y_i represents yield of cotton for the *i*-th farm, x_i is a vector of k inputs (or cost of inputs) and the detail of independent variables is summarized as follows,

X_1= Amount of seed (kg/acre)
X_2=Amount of labor (Hired, family/acre)
X_3=NPK, Nutrient/acre
X_4=Hours of irrigation/acre
X_5=Cost of pesticide (Rs/acre)
X_6=Tractor hours/acre

β is a vector of k unknown parameters, ε_i is an error term. The stochastic frontier is also called "composed error" model, because it postulates that the error term ε_i is decomposed into two components: a stochastic random error component (random shocks) and a technical inefficiency component which is elaborated as follow,

$$\varepsilon_i = v_i - u_i \qquad (2)$$

Where v_i is a symmetrical two-sided normally distributed random error that captures the stochastic effects outside the farmer's control (e.g. weather, natural disaster, and luck), measurement errors, and other statistical noise. It is assumed to be independently and identically distributed $N\left(0, \sigma_v^2\right)$. Thus, v_i allows the frontier to vary across farms, and therefore, frontier is stochastic. The term u_i, is one sided ($u_i \geq 0$) efficiency component that captures the technical efficiency of the *i*-th farmer. The one-sided error term could have different distributions but we assumed u_i follows a truncated distribution. The truncation-normal distribution is a generalization of the half-normal distribution. It is obtained by the truncation at zero of the normal distribution with mean μ, and variance, σ_u^2. The two error components (v and u) are also assumed to be independent of each other. The variance parameters of the model are parameterized as:

$$\sigma_s^2 = \sigma_v^2 + \sigma_u^2; \; \gamma = \frac{\sigma_u^2}{\sigma_s^2} \; and \; 0 \leq \gamma \leq 1 \qquad (3)$$

The parameter γ must lies between 0 and 1. The maximum likelihood estimation of equation (1) provides consistent estimators for β, γ, and σ_s^2 parameters. Hence, equation (1) and (2) provide estimates for v_i and u_i after replacing ε_i, σ_s^2 and γ by their estimates. Multiplying by e^{-v_i} of both sides of equation (1) and replacing β's with maximum likelihood estimates yields stochastic production frontier as:

$$\dot{y}_i = F\left(x_i, \beta^{\otimes}\right) e^{-ui} = y_i e^{-vi} \qquad (4)$$

Where $\dot{y}_i$ is the yield of cotton of the *i*-th farm adjusted for the statistical random noise captured by v_i (Bravo-Ureta, and Rieger 1991). All other variables are as explained earlier and $\beta^{\otimes}$ is the vector of parameters estimated by maximum likelihood estimation technique. The technical efficiency (TE) relative to the stochastic production frontier is captured by the one-sided error components $u_i \geq 0$, i.e.

$$e^{-u_i} = \left[\frac{y_i}{F\left(x_i, \beta^{\otimes}\right) e^{v_i}}\right] \qquad (5)$$

Technical inefficiency (**IE**$_i$) could be estimated by subtracting technical efficiency from one. The function determining the technical inefficiency effect is defined in general form as a linear function of socio economic and management factors as discussed below,

$$IE_i = F\left(Z_j\right) \qquad (6)$$

Where

Z_1 = Number of schooling of the farmer (years)

Z_2 = Age of the farmer (years)
Z_3 = Operational area (Acres)
Z_4 = Tenancy Status of the farmers, if owners the dummy for tenancy is 1, otherwise 0
Z_5 = Availability of credit, if availed then 1, otherwise 0
Z_6 = Power source, if own tractor then 1, otherwise 0
Z_7 = Location of farm at water course, if located at head of watercourse then 1, otherwise 0

However, it should be noted here that technical efficiency model and inefficiency effect model is not estimated step by step as discussed above rather study employed Frontier 4.1 program developed by Coelli (1994) to estimate the coefficient of production function and inefficiency effect model by choosing the option of inefficiency effect model.*

Data Collection Procedure

Analyses is carried out by using primary data collected during the year 2005-06 from 120 farm households' belonging to the Muzaffar Garh District of Punjab. Five villages are selected on the basis of maximum area under cotton cultivation. Two villages are located in Jatoi Tehsil and the remaining three are in Muzaffar Garh Tehsil. Twenty four farmers from each village is randomly selected in such a way that 8 farmer are selected from each of the three category (small, medium, and large). A farm is considered to be small if the size of operational farm area is less than or equal to 12.5 acres, medium if operational farm area is greater than 12.5 and less than 25 acreage and farmer is assumed to be larger if he has operational farm area greater than 25 acreage. The data is collected by the interview method.

RESULTS AND DISCUSSION

The average value of summary statistic for different relevant variables is reported in Table 1. The highest average age is observed in case of large farmers followed by small and medium farmers indicating that larger farmers have better access to facilities and good food because of having better financial conditions. The highest value of crop and land use intensity is observed at small farms followed by medium and large farms, indicating that small farms have more pressure to generate income from their farms to run their families.

Among small farm group only 45 percent have excess to canal and own tube well water and 40 percent have excess to canal and hired tube well water as a source of irrigation implying that only 5 percent have their own tube well in this group. Among the medium farmers, 77.5 percent have availability of canal and own tube well water and 10 percent had canal and hired tube well water as source of irrigation implying that a large majority of medium farms have their own tube well. Among the large farm group, 80.5 percent have availability of canal and own tube well water and 9.5 percent have canal and hired tube well water as source of irrigation implying that about 70 percent have their own tube well. The results clearly depict that as farm size increases, the farmer have better excess to irrigation water either from canal irrigation or from their own tube well. This implies that large farmers have better excess to irrigation facilities.

The percentage of farmers having their own tractor was 10, 27 and 60 percent for small, medium and large farmers, respectively. The percentage of owned tractor increases with increases in farm size indicating that large farmers have better access to modern technology because of having more financial resources. The results demonstrate an increasing trend in contacts with Agricultural Extension Staff with an increase in farm size. Again it is reflecting that as farm size increases the importance of role of extension is realized more seriously. It implies that large farmers have better vision about the role of extension worker to enhance agricultural productivity in cotton production and it might be because they have higher education level.

Our results indicated that large farms availed more credit followed by medium and small farms. Once again it is an evident that large farms have better access to credit. It implies that donor agencies should focus more on small farmers to increase the farm productivity because different indicators demonstrate that the group of small farmers are lacking behind in adopting modern techniques of production mainly due to financial constraints.

The highest number of irrigations per acreage is used by large farmers followed by medium and small farmers. This is due to their greater access to canal irrigation water as compared to small farmers. The least cost of irrigation for large farmers followed by medium and small farmers in Table 1 also support this argument. The average amount of soil nutrients; (Nitrogen and Phosphorous) available to cotton crop are 58, 76 and 77 kilograms for small, medium and large farmers, respectively. It indicates that the nutrient used in cotton crop are directly proportional to farm

*This option allows Frontier 4.1 to estimate the coefficient of production function (MLE) and inefficiency effect model in one step as proposed by Wang and Schmidt (2002) size and similar trend is observed in case of average cost of nutrients as reported in Table 1. The highest number of pesticide sprays is observed in case of large farmers followed by medium and small farmers.

Our results are indicating an inverse relationship between labor used and farm size, implying that larger farmers are employing labor saving technology more intensively than medium and small farms. The results of input cost reported in Table 1 are indicating that small farmers are depending more heavily on family labor but large farms employed more hired labor. This depicts that small farms have more severe cash constraints than large farms. Probably this is the reason that why education level is low at small farms because their household members are involved more heavily in farm related activities. Number of tractor hours used for different operations in cotton cultivation shows an increasing trend with an increase in farm size but on the other hand cost of tractor has inverse relation with farm size indicating that large farmers have their own tractors while small farmers are depending more on hiring of tractors. The cost figures reported in Table 1 are indicating that pesticide use is higher at the large farms compared to other two categories, implying that large farms are more cautious about their cotton crop and have less cash constraints.

The highest average total cost of production for cotton crop is observed in case of large farms followed by medium and small farms. This indicates the severity of cash constraints at small farms which need to be focused in future policies. The highest average total revenue is observed at large farms followed by medium and small farms and similar trend exists in case of net profit as reported in Table 1.

Results of Production Function

The results of production function and inefficiency model are reported in Table 2. The coefficient for seed quantity variable is 0.42, 0.55 and 0.29 for small, medium and large farms, respectively which is significant at 10, 1 and 20 percent level, respectively. As the quantity of seed increases, more number of plants per acre is available and this will lead to produce more number of bolls which will appear in terms of higher yield.

For small, medium and large farmers, the coefficient for number of irrigations variable is 0.59, -0.65 and -0.07, respectively. For small and medium farmers, it is significant at 10 and 20 level but in case of large farms it is non-significant. The negative coefficient for medium and large farms might be due to the fact that medium and large farmers are influential sector of the society; they often deprive the small farmers of their right to use canal water for irrigation. Therefore, two categories of farms (large and medium) have abundance of canal irrigation water. The frequent use of irrigation water in cotton crop affects the yield negatively. Most probably medium and large farmers are giving more water to their crop than needed which is affecting their output negatively. That is why we got negative sign of irrigation for both medium and large farm groups. The second reason could be that these two groups have better excess to tube well water which is low in quality and therefore, affecting the yield of cotton negatively.

The coefficient of fertilizer nutrients is -0.01, 0.10 and 0.12, for small, medium and large farms, respectively. It is non significant for small farmers but for medium and large farmers it is significant at 20 percent level. It has been discussed above that small farmers are not frequently contacting with extension workers and therefore, it might be possible that small farms are not using proper combination of fertilizer with other inputs or they are not using fertilizer at the proper time.

The pesticide use has different impacts on different farm size groups. The coefficient of pesticide in production function estimation was 0.43, -0.13 and 0.09, for small, medium and large farms, respectively. For small and large farmers, it is significant at 10 percent and 20 percent level, respectively. This is because of the fact that small farmers use family labor for pesticide application, therefore they use pesticide on time. On the other hand large farmers use machinery for pesticide spray and can easily control insects attack through timely application of the pesticide. The negative sign of pesticide use for medium farmers might be due to the fact that medium farms mainly use casual hired labor for pesticide spray and due to cash constraint; medium farmers could not hire labor on time.

The coefficient of labor (used in land preparation, plowing, hoeing, irrigation, fertilization, pesticide etc) in production function was -0.02, -0.00 and -0.23 for small, medium and large farms, respectively and it is found to be non-significant for small and medium farms while it is significant at 10 percent level for large farms. The negative sign could be due to the reason that labor is over utilized in the production process of cotton.

The tractor hours used for different operations in cotton cultivation for small, medium and large farms is significant at 20 percent level. The coefficient is 0.19, 0.48 and 0.13 for small, medium, and large farms, respectively.

Technical Inefficiency and its determinants

Given a particular technology to transform physical inputs into outputs, some farmers are able to achieve maximum efficiency. This discrepancy in the later group can be because of not having adequate technical knowledge. Timmer (1971), Muller (1974), and Kalirajan and Shand (1989) have suggested that the technical efficiency of farmers is determined by socio-economic and demographic factors and resource endowments.

The negative coefficient for education implies that farmers with greater years of schooling tend to be technically more efficient and it is logical and consistent because education improves the ability of a farmer in decision making process. Our findings are along the line with Flinn and Ali (1986). However, the results are in contrast with the findings of Phillips and Marble, (1986) for Guatemala, and Belbase and Grabowski, (1985) for Nepal.

The positive coefficient for age indicates that as age increases inefficiency increases and it is consistent with the theory that as farmers get old physically they become weak and this will lead to higher level of inefficiency. Hence, it is reasonable to conclude that younger farmers are more efficient than the old ones. However, Battese *et al.* (1996) conclude that age is positively related to technical efficiency, presumably because of greater experience and technical knowledge. The reason to support our results is that younger farmers are more energetic as well as more innovative than the old farmers. Old farmers on the other hand are found to believe in traditional farming operations and are not able to perform and supervise most of the farming activities based on modern technology.

The coefficient of cropped area suggests that as cropped area in cotton production increases, inefficiency decreases. The coefficient was significant for small and large farm groups but it was found to be non-significant for medium farm group. It is observed and explained above that as the operational or cropped area increases, the farmers have better access to various inputs like seed, fertilizer, pesticide and canal irrigation etc. This would lead to increase in efficiency level. Our results are consistent with the findings of Byrnes, *et. al.* (1987) for small and medium farm groups but for large farm group results is opposite. In our case large farmers are technically less efficient. The reason behind this is that the average level of education of large farmers is lower than that of the medium farmers which is trickling down the efficiency level.

The negative coefficient for tenancy status show that the efficiency of the farmers increases with an increase in ownership implying that owners are more efficient than the tenants. Probably it could be due to the reason that tenants are often reluctant to invest more in land management strategies which they don't own and hence, they usually adopt conventional method of cultivation. However our findings contrast with Lingard, *et.al* (1983) where they observed that tenants are comparatively more efficient than the owners.

The sign of coefficient for credit variable for small and medium farmers are negative indicating that there exists a direct relationship between credit and the technical efficiency of the farmers. Credit, no doubt, improves farmer's liquidity and facilitates the purchase of inputs besides encouraging them to introduce improved varieties. These results are consistent with earlier argument that small and medium farmers are facing more severe cash constraints which is hindering them to adopt modern technology such as tractor etc. However, positive sign of credit for large farm group implies that technical efficiency decreases with the increase in credit facility for large farm group. It might be due to the reason that large farmers have no cash constraints and therefore, availability of credit encourage them to involve in non-farm activities which divert their attention to take right decision at the right time on their farms. Lingard *et al.* (1983) concluded that credit has a positive impact on efficiency but they did not study the impact of credit on different farm size groups as we are considering in the present study. Our results clearly suggest that credit donor agencies should focus on small and medium farms because the provision of credit to these groups will significantly contribute to enhance the technical efficiency of these groups.

The negative sign of coefficient of power source shows that ownership of tractor had a positive impact on technical efficiency of farmers. Availability of own tractor insures the timely operations necessary for cotton cultivation and increase the technical efficiency of farmers.

The sign of coefficient for location of farm at watercourse was observed to be negative, implying that farmers at head of the watercourse are technically more efficient than those located at the middle and tail of the watercourse. This is because of the fact that there is an easy access to canal water for farmers at head of the watercourse which is expected to contribute positively to improve efficiency because timely irrigation of the crop increases the technical efficiency of the farmers.

The results of the analysis show that on an average there is 10 percent technical inefficiency in cotton Crop. This implies that actual output is 10 percent less than the maximum attainable output from the given set of resources. This clearly depicts that from the existing resource 10 percent higher level of output could be achieved just by allocating the existing resource more efficiently. The mean level of technical efficiency is found to be 91% with a minimum of 49% and a maximum of 99% for small group of farmers (Table 3). The mean technical efficiency for medium group is 93% with minimum and maximum level of 77% and 100%, respectively. However, mean technical efficiency for large farm group is lowest 89% with minimum and maximum of 81% and 97% respectively. As discussed earlier that large farmers had better access to education, irrigation facilities and modern technology because of having comparatively better financial condition. Therefore, it is expected that large farmers should have higher efficiency compared to other groups. However, empirical results found to be opposite, indicating that large farmers are not using the existing resource as efficiently as small and medium farm group.

The results revealed that education level, farm size, tenancy status, power source, location of farm at watercourse and credit are positively associated with technical efficiency, while the age is found to be inversely related with technical efficiency. Moreover, medium farmers are found to be technically more efficient as compared to small and large farms. This finding is in line with the results obtained through summary statistics (Table 1) which suggests that yield of medium farmers are greater than small farmers and is almost equal to large farmers.

The results show a wide variation in the level of technical efficiencies across farms. In a sample of 40 small farmers, 29 have efficiency 90 percent or above 90 percent. Among the group of medium farmers, 31 farmers have efficiency greater than or equal to 90 percent but in a group of large farmers, only 15 farmers have efficiency greater than or equal to 90 percent indicating that in large farm group lowest number of farmers fall in highest efficiency class. However, among large farmers there are 25 who have efficiency in the range of 80 to 90 percent.

CONCLUSIONS

The total farm sample divided into three categories, small (operational area less than or equal to 12.5), medium (operational area ranging between 12.5 and 25 acres), and large (operational area greater than 25 acres) to study farmer-specific characteristics. Generally it is observed that large farmers have better access to education, canal irrigation water, and modern technology and they have less cash constraints compared to small farmers.

A stochastic frontier production approach is employed to measure the technical efficiency of cotton farmers and factors affecting the inefficiency of cotton farmers are also identified. More precisely a Cobb-Douglas type of production is selected to estimate technical efficiency of cotton farmers in the study area. The results of the Maximum Likelihood estimate indicated that on an average cotton farmers are 90 percent technically efficient in all three farm size groups. The least technical efficiency level is found to be 49 percent in small farm category. Mean technical efficiency for three groups (small, medium and large) is not significantly different from each other. However, important findings of the present study is that different variables such as resource endowments of the farmers (power source), credit availability, location at water course, have different impact on farm efficiency for different farm groups (small, medium, and large).

In order to develop policy parameters, a relationship between technical inefficiency and farm characteristic, socioeconomic factors and household resource endowments is established. The results indicated that the technical efficiency is positively associated to education, operational area, tenancy status, credit, power source and location of the farm at the water course and is negatively associated to age of the farmers, implying that provision of credit, canal irrigation, and power source could play a significant role to improve their efficiency level.

The results, clearly suggests that future policy should be directed to provide more credit to small farmers in such a way that they should invest this credit to purchase modern technology, e.g. tractor, and to install their own tube well. Education is another important variable contributing to reduce inefficiency for all three farm size categories implying that investment on education could play a significant role to improve cotton production in the study area.

REFERENCES

Aigner, D.J., Lovell, C.A.K., and Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models, Journal of Econometrics, 41(1), 62-74.

Barrett, C.B. (1998), On price risk and the inverse farm size-productivity relationship. J. Development Economics. 51, 193-215.

Battese, G.E. (1992). Frontier Production Functions and Technical Efficiency: A Survey of Empirical Applications in Agricultural Economics, Agricultural Economics, 7, 185-208.

Table 1. Summary Statistics for Different Variables by Farm Size Categories of Cotton Farmers in Punjab, Pakistan

Type	Small Area ≤12.5Acres	Medium 12.5acre<Area≤25 acre	Large Area >25acres	Unit
Age	38.07	33.22	41.12	Year
Education	2.47	7.56	8.67	Year
Area owned	2.7	13.27	63.42	Acre
Operational area	4.67	17.01	46.53	Acre
Cropping Intensity	193.44	190.32	185.55	%Age
Land Use Intensity	98.23	98.11	97.42	%Age
Own Tractor	10	27.5	60	%Age
Contact with Ext. Staff	12.5	52.5	57.5	%Age
Credit availed	40	77.5	80	%Age
Yield	19.88	20.34	19.38	Maund
Quantity of seed	6.0	6.4	6.3	Kg
Irrigations	5.7	6.2	6.4	No
Nitrogen	45	55	54	Kg
Phosphorous	13	21	23	Kg
Pesticide Sprays	6.3	7.8	8.4	No
Farm Labor	11.6	10.2	7.6	Day
Tractor Hours	5.5	6.9	7.4	Hour
Total cost	8703	9838	11736	Rs
Total Revenue	17600	21100	21600	Rs
Profit	8897	11262	11764	Rs

Table 2. Maximum Likelihood Estimates for different Farm Size Categories

Production Coefficient	Small Area ≤12.5 acres	Medium Area 12.5 ≤25 acre	Large Area >25 acres
Constant	0.16 (0.63)	1.12 (1.21)	1.22 (1.66)
Seed Quantity/acre (Kgs)	0.42** (1.38)	0.55*** (1.61)	0.29* (1.20)
No. of Irrigations	0.59** (1.46)	-0.65* (-1.16)	-0.07^{ns} (-0.56)
Fertilizer Nutrients (Kgs)	-0.01^{ns} (-0.16)	0.10* (1.27)	0.12* (1.24)
No. of pesticide applications	0.43** (1.41)	-0.13* (-1.14)	0.09* (1.11)
Labor days	-0.02^{ns} (-0.36)	-0.00^{ns} (-0.05)	-0.23** (-1.46)
Tractor Hours	0.19* (1.20)	0.48* (1.22)	0.13* (1.21)
Inefficiency Effect Model			
Constant	-0.13 -0.52	0.17 1.10	0.16 1.24
Education	-0.00^{ns} (-0.34)	-0.02* (-1.21)	-0.00* (-1.10)
Age	0.01** (1.32)	0.00^{ns} (-0.11)	0.00* (1.14)
Cropped area	-0.06** (-1.31)	-0.00^{ns} (0.43)	-0.00* (-1.17)

Tenancy Status	-0.07^{ns} (-0.92)	-0.08^{ns} (0.79)	-0.01* (-1.13)
Credit availability	-0.21* (-1.23)	-0.00^{ns} (-0.08)	0.01* (1.12)
Power source	-0.51** (1.39)	-0.11* (-1.19)	-0.10* (-1.11)
Location of farm at water course	-0.17* (-1.21)	-0.02^{ns} (-0.38)	-0.01^{ns} (-0.81)
Sigma squared	0.01 (1.36)	0.00 (1.19)	0.00 (1.41)
Gamma	0.80 (2.13)	0.99 (2.56)	0.99 (0.69)
Log likelihood function	2.56	2.75	2.89

Note: Values in brackets represent t-ratio.
***=*Highly significant* at 1% level, **=*Significant at 10% level*, *=*significant at 20% level*, ^{ns}=Not significant

Table 3. Frequency Distribution of Technical Efficiency for Individual Farms

Efficiency (%)	**Small** Area ≤12.5Acres	**Medium** 12.5acre<Area≤25acre	**Large** Area >25acres
1.00>E≥0.90	29	31	15
0.90>E≥0.80	8	7	25
0.80>E≥0.70	1	2	0
0.70>E≥0.60	1	0	0
0.60>E≥0.50	0	0	0
0.50>E≥0.40	1	0	0
Mean	91.79	93.29	88.89
Min	49.11	77.16	81.07
Max	99.18	99.86	97.27

REFERENCES

Battese, G.E., (1996). Frontier Production Functions and Technical Efficiency: a Survey of empirical applications in agricultural economics. Agric. Econ.7, 185-332.

Belbase, K., and Grabowski, R. (1985). "Technical Efficiency in Nepalese Agriculture", Journal of Developing Areas, Vol. 19, 515-525.

Bravo-Ureta, B.E., and Rieger, L. (1991). Dairy Farm Efficiency Measurement Using Stochastic Frontiers and Neoclassical Duality. American Journal of Agriculture Economics 73 (2): 421–28.

Byrnes, P., Fare, R., Grasskopf, S., and Kraft, S. (1987). Technical efficiency and size: the case of Illinois grain farms, European Review of Agricultural Economics, 14: 367-381.

Carter, M., and Wiebe, K. (1990). Access to capital and its impact on agrarian structure and productivity in Kenya. American Journal of Agriculture Economics. 5, 1146-1150.

Coelli, T.J. (1994). A Guide to Frontier Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation. Mimeo, Department of Econometrics, University of New England, Armidale.

Coelli, T.J. (1996). A Guide to DEAP Version 2.1. A Data Envelopment Analysis (Computer Program). Center for Efficiency and Productivity Analysis, Department of Econometrics, University of New England, Armidale, NSW, 2351, Australia.

Coelli, T.J., and Perelman, S. (1999). A comparison of Parametric and Non-parametric Distance Functions: With Application to European Railways, European Journal of Operational Research, 117, 326-339.

DFID (2005) "Growth and poverty reduction: the role of agriculture" Policy paper. DFID, London. Available at http://dfid-agriculture-consultation.nri.org/process.htm

Flinn, J. C., and Ali, M. (1986). Technical Efficiency in Basmati Rice production", Pakistan Journal of Applied Economics, Vol.. 1, 63-79.

Govt. of Pakistan. (2005). Economic Survey of Pakistan 2004-05, Finance Division, Islamabad.

Govt. of Pakistan. (2006). Economic Survey of Pakistan 2005-06, Finance Division, Islamabad.

Hayami, Y., and Ruttan, V. (1985). Agricultural Development: an International Perspective. Johns Hopkins University Press, Baltimore, 512 pp.

Johnson, N., and Ruttan, V., (1994). Why are farms so small? World Develop.5, 691-706

Kalirajan, K., and Shand R. T., (1989), A Generalized Measure of Technical Efficiency, Journal of Applied Economics, Vol. 21, 25-34.

Kebede, (2001). Farm Household Technical Efficiency: Stochastic Frontier Analysis, Study of Rice producers in Mardi Watershed in the Western Development Region of Nepal. Masters Thesis submitted to Department of Economics and Social Sciences, Agricultural University of Norway.

Lingard J., Castillo, L., and Jayasuriya, S., (1983), Comparative Efficiency of Rice Farmers in Central Luzon, The Philippines Journal of Agricultural Economics, Vol. 34, 163-173.

Meeusen, W., and Van. J., (1977). Efficiency estimation from Cobb-Douglas production with composed error, International Economic Review, 18,435-444.

Muller, J. (1974), On Measuring Sources of Measured Technical Efficiency: The Impact of Information, American Journal of Agricultural Economics, Vol. 4, 29-36.

Phillips, M. J. and Marble, R. P., (1986), Farmer Education and Efficiency: A Frontier Production Function Approach, Economics of Education Review, Vol. 5

Timmer, C. P. (1971). Using the Probabilistic frontier Function to measure Technical Efficiency, Journal of Political Economy, Vol. 79, 776-794.

Villano A. Renato (2005). Technical Efficiency of Rainfed Rice farms in the Philippines: A Stochastic Frontier production Function Approach. Working paper, School Economics, University of New England Armidale, NSW, 2351.

Wadud, (1999). Farm Efficiency in Bangladesh, Ph.D. Thesis. Department of Agricultural Economics and Food Marketing, University of Newcastle upon Tyne, U.K.

Wang H. J. and Schmidt, P. (2002) One Step and Two Steps Estimation of the Effects of Exogenous Variables on Technical Efficiency Levels. Journal of Productivity Analysis 18 (2002): 129-44.