TECHNICAL EFFICIENCY OF COTTON FARMERS: EVIDENCE FROM PUNJAB (PAKISTAN)

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Abstract

The paper analyses the technical efficiency of the cotton farmers of the Muzaffargarh District in Punjab province of Pakistan. Data collected from the cotton farmers through the questionnaires study. Data collection carried out for the growing season of 2010-11. Cobb-Douglas production function is specification for the Model. The technical inefficiency effect found to present. The mean predicted technical efficiency of cotton farmers was0.72 which to be ranging to 0.29 to 0.99. The result of the frontier model points out that cotton production could be increased through increasing the cotton area seed, irrigation, cultivation, labor and fertilizer use while the over use of the pesticides negatively affects. The technical inefficiency model explains that inefficiency of the farmers can reduced through the increasing the farm area education increasing contact to agriculture expert's cultivation owner tube well and fertilizer usage while the technical inefficiency increases through the using Drill for sowing seed and water shortage.

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Introduction

Developing countries in the world are mostly having the agrarian based economies. In such developing countries' economies are driven through the agriculture in term of employment, share in GDP, public revenue and export. In the current scenario of world increasing population and food crisis, the place of agriculture sector broadly accepted throughout the world. Now it focuses to agriculture development to attaining the goals through increasing productivity and efficiency.

Despite more than 50 years of the vigorous industrialization, agriculture is still stronghold of the economy in terms of its contribution to GDP, employment and foreign exchange earnings of Pakistan. That 44% of country s, work force not only employed in agriculture but also 67.5% of population living in rural areas directly and indirectly linked with agriculture for their livelihood. Whatever happens to agriculture is bond to affect not only the country's growth performance but a large segment of the country's population as well. Agriculture dominates Pakistan's economy in term of GDP share thought it has declined from 25.9% of GDP in 1999-2000 to 20.9% in 2010-11(Pakistan Bureau of statistics (2010-11).

Kharif and Rabi are the two principle crop seasons in Pakistan. Kharif crops are Rice, sugarcane cotton, maize; pulses grown in the former while the wheat gram, lentil tobacco, Rapeseed, Barlay and mustard are the Rabi crops. The wheat, cotton, rice, sugarcane are the major crops that accounts for 90 percent of the value-added in the major crops (PBS2010-11).

Cotton has a significant role in the national economy of the Pakistan. Its fiber used as a raw material in the textile industry is the major source of the foreign exchange earnings. Cottonseed serves as the raw material in the oil industry and its cake used by the stockbreeder as a feed. Cotton farming and processing constitutes a large channel for employment. Pakistan is the fifth producer of cotton production after China, USA, India and Brazil with a share of 7.7% of the world cotton production (International cotton Advisory Committee 2011).

The performance of raw cotton in the country carries much importance, as Punjab is the main cotton-growing province in the country with the share of 78% of total cotton production in the country while the Sindh province shares of the 20% of cotton production and KPK and Balochistan play minor role in cotton production (Federal Bureau of statistics (FBS) 2010-11). Keeping in view the importance of cotton crop and its productivity level Punjab province has been Pakistan divided into three zones based on area and production of cotton crop (Tables 1).

Table1 Cotton Production Zones in Punjab

Area specified	Districts	Production (%)
Core zone	R.Y.Khan, Multan, Bahawalpur, Khenewal Vehari, Lodhran, Rajanpur, Bahawalnagar, Muzaffargarh, D.G.Khan	90.72%
Noncore zone	Faisalabad, T.T.Singh, Jhang, Sahiwal, Okera, Pakpattan	8.50%
Marginal one	Bhakkar, Mianwali, Khushab, Sargodha, Gujrat, Sialkot, Jehlum, Qasur	0.78%

Pakistan Central Cotton Committee (2006-07)

The core zone of cotton production produces more than 90% of the cotton in Punjab. While the noncore zone produces more than the 8% of cotton and the marginal zone just produces the less than 1% of cotton production in Punjab (Pakistan Central Cotton Committee 2006-07).

Several recent studies on the technical efficiency of the crop production pointed out the existence of yield gap. only few studies of cotton crop in Pakistan Battese and Hassan(1999) Hussain(1999) and Abdullah(2006) findings of these studies points out to improving the efficiency measures to increasing the yield productivity. Iqbal et al., (2001) found that timely availability of inputs such as seed fertilizer weedicates and pesticides could enhance cotton crop productivity.

Increasing the use of inputs to increase production efforts should made toward output growth through improved technical efficiency producing more by existing resources input more efficiently (Sharma and Leaung 2000). The trend of increasing revenue for improving technical efficiency gives some indication that increased production may provide revenue source to the limited resource farmers (Kebede and Gan 1999).

According to Viallano (2005), the gap refers to the difference in productivity on best practice and other farm operating with compare able resource endowments under similar circumstances. the difference between actual and technically feasible for most crop implies great potential for increasing agriculture production through improvements in productivity even without further advancements in technology and employment of additional resources (land labor and water etc).it is generally believes that the resources in the agriculture sector especially developing countries are being utilized inefficiently.

The present study is attempting to establish a relationship between resource endowments and technical efficiency in cotton production in Pakistani environment study is oriented toward the goal of achieving the higher productivity by improving the technical efficiency of cotton farmers. It is expected to lead the policy managers to decide where future resources should be allocated to improve the cotton productivity. The key objectives of present study are to estimate the technical efficiency of cotton farmers and elaborate the reasons of inefficiency if any.

The scheme of the paper is as follow the second section delineates the empirical model and Data collection procedure. The third section presents the empirical results discussions. Last section derived conclusions and suggestions.

Empirical Model and Data Collection Procedure

Variation in output is affected mostly three reasons fluctuations in inputs, technical inefficiency and the random shocks. The variations in the output due to the technical inefficiency and random shocks can decompose through the stochastic production frontier approach. Technical efficiency mostly measured through the stochastic frontier approach known as the parametric approach and Data envelopment analysis (DEA) which is the non-parametric approach. Advantages and disadvantages of each approach have been discussed Coelli (1996) and Coelli and Perelman (1999).However the approach of DEA works under the assumption no random shock in the data set.

Stochastic frontier production method has been use in the present study due to the facts that random shocks are more prevalent in the production of cotton. Stochastic frontier production function method incorporates random shocks, measurement error separately effects of the random shocks, and measurement error is independently estimated while determining technical efficiency (Parikh and Shah 1994, Battese and Hassan 1999, Hassan 2004).

Cob-Douglas type production function was use in this study despite its limitation due to its ease of computation and interpretation (Battese 1992, Bravo-Ureta and Pinherio 1993, Battese and Hassan 1999, Hassan 2004). The empirical Cob Douglas type model given below

$$Ln\ Y_{\square} = \beta o + 8\sum\beta_{\square} + ln\ X_{\square} + v_{\square} - u_{\square} \qquad (1)$$

. $i = 1,2\ldots\ldots\ldots\ldots.8.$

Xt is the vector of k inputs used in the cotton production while the βo, βi are unknown parameter to be estimate.

Yi = Explains the total cotton production (in maunds) of the farmer

X1 = explains the Total area of cotton crop production (in acres)

X2 = Quantity of Seed (in kg) per acre

X3 = Pure nitrogen applied to the unit area (kg) per acre

X4 = Pure phosphorus applied to unit area (kg) per acre.

X5 = Cost of pesticides used against germs and weedics in (Rs) per acre.

X6 = Number of irrigation per acre (canals and tube well).

X7 = Number of family labor adult worked at farm operations.

X8 = Number of cultivation per acre times area of cotton grown.

Vi is random error accounting for measurement error and other random factors outside the control of the farmers and it is assumed that it is independently and identically distributed normal variable with mean zero and constant variance σ^2□ independent of the u s. The us shows the technical inefficiency effects and they are associated with the technical inefficiency of the farm enterprise. U,s are non negative random variables associated with the technical inefficiency of production of farmers. Such that technically effects for the ith farmer growing of cotton is obtained by truncation of normal distribution with mean Ui and variance σ^2 such that

U□ = Ʒ □Ψ + w□ (2)

Ui = Non-negative random variable explains the technical inefficiency of the production farmers.

Ʒ 1i = Age of farmer in years, which are operating the farm

Ʒ 2i = Education or schooling years of farmer.

Ʒ 3i = Family size of the farmer

Ʒ 4i = Operational farm area in acres

Ʒ 5i = Dummy variable 1 if received Credit from bank or dealer otherwise (0)

Ʒ 6i = Dummy variable sowing through Drill or not (1) other (0).

Ʒ 7i = Dummy variable tube well own (1) otherwise (0).

Ʒ 8i = Canal water shortage fulfilled through the tube well.

Ʒ 9i = Dummy variable1 if indicating the contact to the agriculture extension otherwise (0

Ʒ 10i = Dummy variable (1) if sowing cottonseed in time otherwise (0).

The Ψ are unknown parameters to estimate. The w□ is an error term independent and identically distributed.

Data Collection Procedure

Data gathered in various aspects of cotton cultivation. Survey data contained information on socio-economic characteristics of the farmer land status management practices input-output quantities. The study used the primary data which was collected through the questionnaires from the 100 a sample farmers from the district Muzaffargarh which consists the four tehsils Muzaffargarh, Kot addu, Jatoi and Alipur. Tehsil Alipur randomly selected for this study.

Table-2 Basic Statistics on per Acre Basis

Efficiency Level				
	Mean Value	Standard error	Minimum Value	Maximum Value
Efficiency (%)	0.7231	0.1809	0.2896	0.9999
Cotton production(Munds)	358.53	320.52	14	1430
Seed (kg)	8.08	1.49	4.5	10
NitrognFertilizer(kg)	220.75	73.17	100	400
Phosphorus Fertilizer(kg)	31.42	28.39	2	100
Pesticides cost(Rs)	8903	4260	1500	25000
Irrigation (No)	7.32	1.61	4	10
Family Workers (No)	2.44	0.62	2	5
Cultivation (No)	7.69	2.84	3	15
Age of farmer (years)	44.5	11.38	20	70
Education (year of schooling)	7.21	4.24	0	16
Family Size (no)	9.94	4.70	2	29
Farm Area (Acres)	16.74	12.89	1.5	50
Credit (dummy)	0.72	0.451	0	1
Sowing Drill (dummy)	0.67	0.472	0	1
Tube well own(dummy)	0.66	0.476	0	1
Water shortage (%)	29.54	16.61	5	70
Contact Agri Extension(dummy)	0.63	0.485	0	1
Sowing Timely(dummy)	0.71	0.456	0	1

Results and Discussions

The maximum likelihood estimates of cob Douglas type production function and inefficiency effect model were estimated using computer software Frontier 4.1 developed by Coelli(1996). Table 2 indicates the estimates of the MLE of cob-Douglas production function along with estimates of determinants of technically inefficiency effect model.

Table-3 Maximum likelihood Estimates for Parameter of Stochastic Frontier Production

Function and inefficiency Model

Variable	Parameter	Standard Error	T-value
β	0.333	0.253	0.131
Ln Cotton area(Acres)	0.922	0.153	6.015
Ln Seed(kg)	0.516	0.549	9.402
LnNitrognFertilizer(kg)	0.705	0.359	1.963
LnPhosphorus Fertilizer(kg)	0.470	0.102	4.602
LnPesticides cost(Rs)	-0.202	0.200	-1.010
Ln Irrigation (No)	0.384	0.542	7.098
Ln Family Workers (No)	0.154	0.158	9.744
Ln Cultivation (No)	0.155	0.385	4.037
Inefficiency Model			
Ψ	0.365	0.174	0.209
Age of farmer (years)	-0.219	0.224	-0.997
Education (year of schooling)	-0.114	0.912	-0.125
Family Size (no)	-0.879	0.508	-0.172
Farm Area (Acres)	-0.817	0.189	-0.432
Credit (dummy)	-0.157	0.798	-0.196
Sowing Drill (dummy)	0.124	0.113	0.109
Tube well own(dummy)	-0.301	0.499	-0.603
Water shortage (%)	0.931	0.233	0.398
Contact Agric Extension(dummy)	-0.124	0.110	-0.112
Sowing Timely(dummy)	-0.118	0.565	-0.209
Variance Parameters			
$\sigma^{2\ s}$	0.152	0.306	0.496
ϒ	0.999	0.762	0.131
Log-Likelihood function	0.88		

Maximum likelihood estimates of the parameters of stochastic frontier production function defined by the equation 1 and 2 presented in the table 2 with the standard error and t-values. Variable cropped area of cotton production with the coefficient of 0.922 which to be explains that one percent increase in the cotton areas will increase the cotton production 0.92 percent. The t-ratio 6.015 which to be the less than one percent level significance while the results are in line with the studies of Hussain(1999) Battese and Hassan(1999) Battese and Broca(1997) Coelli and Battese(1996) Parikh et al (1995) Battese et al (1993) and Ali and Choudhry(1990) and Hassan(2005).

Coefficient of the seed to be the 0.516 which to explains the results that one percent increase in the seed usage would increase in the cotton yield 0.516 percent. The t-ratio to be the 9.402which to be the highly significant at less than one percent the finding of the study to be in line with the previous studies of the Ahmad et al (1999) and Battese and Broca (1997). Two fertilizer categories pure nitrogen and pure phosphorus fertilizers are consider individually.

The coefficient of the nitrogen fertilizer which to be the 0.705 which explains that one percent increase in the nitrogen fertilizer use increase in the cotton production 0.705. The use of the phosphorus fertilizer with the coefficient of the 0.470 explains that one percent increase in phosphorus use increase in the cotton production 0.470 percent. Nitrogen fertilizer t-ratio 1.963which to be significant at ten percent level of significance and the t-ratio of the phosphorus fertilizer with the t-ratio of 4.602 statically significance at one percent The results of the fertilizer variables are in line with the study of the Hassan (2004) Hussain (1999) and Battese, Malik and Broca (1993).

Plant protection measures (Rs per acres) have the negative sign of the coefficient which is the -0.202 which is to be explaining that increase in the one percent in the expenditures of the plant protection measures will decrease the cotton production 0.202 while the calculated t-value to be -1.010 which is negative . The results are in line to the study of Bakhsh (2007), Ahmad and Hassan (2006). The variable of the irrigation which to be coefficient of the 0.384 which to be points out that one percent increase in the irrigation will increase in the cotton production 0.384 percent while the calculated t-value to be the 7.098 which is less than one percent and statically significant. The results are in line with the Hussain (1999) Ahmad (2001) and Hassan (2004).

The coefficient of the labor is to be the 0.154 which to be points out that increase in the one more worker will increase in the cotton production 0.154 while the calculated t-value is to be 9.744 which to be explain the value is significant less than one percent. These elastic ties are consistent with the studies of the Battese et al (1993) Hussain (1999) and Hassan (2004). Coefficient of the cultivation is to be the1.55, which explains that the increase in the one ploughing will increase in the cotton production 1.55 percent while the calculated t-value is to be the 4.037, which is significant at five percent and statically significant. The result is in line with Battese, Malik and Broca (1993) and Hassan (2004).

Technical inefficiency model explains the results. The coefficient of age of the farmer with the negative sign to be explaining that older farmers are more experienced than younger and their expertise reduces the technical inefficiency and increases the technical efficiency the results are in line with the studies of the Hussain (1999) and Coelli (1996). The coefficient of the education with the negative sign explaining that education reduces the technical inefficiency so that the literate farmers less inefficient than the illiterate farmers the result are consistent with the studies of the Hussain(1999) Ahmad(2001) coelli(1996) Battese et al(1993,1996) Rauf(1991) and Hassan(2005).

The variable of the a family size explaining with the negative sign that large families reduces the technical inefficiency cotton farming labor intensive crop due to complicated process such of the results consistent with the studies of the Kalirajan(1990), Parikh et al(1995) and Dhungana et al (2004).

Farm area increases it reduces the technical inefficiency of cotton farmers. According to Sharif and Dar(1996) greater access to the public services like credit and others available to the large farms as comparative to the small farms in the study the negative sign explains the large farms less inefficient than the small farms results consistent with the Kumbhakar et al(1991) and Ahmad et al (2001).

The coefficient of the sowing Drill or other hands own explains the positive sign that sown through Drill increases the technical inefficiency. The coefficient of the dummy variable of the tubewell with the negative sign explains that owner tubewell reduces the technical inefficiency as compared to those farmers, which have no tubewell the results to be consistent with the study of Hassan et al (2006).

Water shortage has positive sign according to expectation. Water shortage to the cotton crop increases the inefficiency of the farmers and the results are consistent with the study of Ali and Flin (1989) and Hassan et al (2006).

Contact to the agriculture extensions having the negative sign according to expectations. Farmer which have continuous contact to the agriculture experts are less inefficient than those farmer which do not havening contact with agriculture experts the results in line with the studies of the Kumbhakar and Bhattacharya(1992), Bravo-Ureta and Evenson(1994), Parikh et al (1995), Bravo-Ureta and Pinherio(1997),Ahmad et al(1999) and Bakhash(2007).

The variable of the sowing in time according to the expected sign which to be negative that timely sowing of the seed of the cotton reduces the technical inefficiency so the farmers who sow seeds in time technical less inefficient those who sow seed late or early the results consistent with the studies of the Hassan(2006). The estimates for the variance parameters σ^2/σ^2_s indicate that the variance σ^2 associated with the inefficiency is about 88% of the two variances.

Table-4 Technical Efficiencies of sample cotton farmers

Farmer Numbers	Technical Efficiency	Farmer Numbers	Technical Efficiency	Farmer Numbers	Technical Efficiency	Farmer Numbers	Technical Efficiency
1	0.35197	26	0.80391	51	0.66251	76	0.79390
2	0.57063	27	0.85586	52	0.83137	77	0.62182
3	0.83289	28	0.61171	53	0.79558	78	0.57128
4	0.99741	29	0.46399	54	0.75909	79	0.76627
5	0.79356	30	0.34801	55	0.68048	80	0.51253
6	0.63001	31	0.94280	56	0.61842	81	0.69586
7	0.72570	32	0.43009	57	0.66180	82	0.79939
8	0.85192	33	0.50028	58	0.99929	83	0.54154
9	0.83669	34	0.73086	59	0 .85731	84	0.76494
10	0.28960	35	0.72395	60	0.65094	85	0.72797
11	0.33561	36	0.48003	61	0.93457	86	0.54777
12	0.69929	37	0.62722	62	0.46973	87	0.66115
13	0.89217	38	0.60175	63	0.40629	88	0.60117
14	0.89159	39	0.39783	64	0.74685	89	0.69650
15	0.59821	40	0.96631	65	0.36883	90	0.88195
16	0.84259	41	0.93522	66	0.83777	91	0.75003
17	0.39670	42	0.81459	67	0.67135	92	0.93888
18	0.88954	43	0.42731	68	0.77348	93	0.78841
19	0.82284	44	0.60877	69	0.99340	94	0. 81493
20	0.81480	45	0.54303	70	0.97717	95	0.83748
21	0.87192	46	0.98987	71	0.99996	96	0.86706
22	0.71468	47	0.52138	72	0.65933	97	0.84606
23	0.54389	48	0.96217	73	0.95011	98	0.73959
24	0.86470	49	0.97348	74	0.80462	99	0.78276
25	0.80164	50	0.99161	75	0.76966	100	0.77698

Mean technical Efficiency = 0.72319

The technical inefficiencies in the technical inefficiency model estimated with the various variables. The predicted technical efficiencies of the individual farmers area to be 100 cotton farmers of the cotton farmers of Punjab with the technical mean value maximum and minimum technical efficiency values to shown in the table. The number of observation is 100 and the mean technical efficiency is 0.72 and the highest level of technical efficiency 0.99 and lowest level of technical efficiency 0.29. The table explains the average loss due to the technical inefficiency 28% but the loss varies the 1% to the 71% among the sample farmers.

Conclusions

The conclusion of the study explains that higher elasticities's of the parameters of the cultivated area (0.922) followed by the fertilizer nitrogen (0.705), seed (0.516) and phosphorus fertilizer (0.470) play the vital role in the production of the cotton. Higher use of the pesticides having negatively effects the cotton production while all parameters of the inefficiency model except sowing drill and water shortage reduces the inefficiency of the cotton farmer. The mean technical efficiency of the cotton farmers (0.72) so there to be much potential to increase the production of cotton while the technical efficiency ranges to 0.29 to 0.99.

Suggestions for the cotton farmers to increasing the technical efficiency and reducing the inefficiency measures of cotton farmers are given below.

Cropped area and cotton production positively related each other's in the same the usages of the fertilizer and seed positively related to the cotton production. In such conditions, cropped area must increase and agriculture authorities must encourage the farmers to increasing the cropped area of the cotton production through the different measures of facilities and incentives. Seed and fertilizer use increases the production so provision of the quality seed and fertilizer on the control rates and subsidies on such inputs positively affect the cotton production.

Pesticides negatively affect the cotton production due to over uses and lower quality of pesticides. Lack of contact to the agriculture extension of the farmers to using pesticides main cause to the lowering the production of cotton in such circumstances agriculture department authorities having to close contact to the farmers specifically during the periods spraying to recommending the quality of pesticides and controlling the over uses of the spraying.

Water shortage increases the technical inefficiency of the farmers while the tube well reduces the inefficiency of the farmers. So the water shortage must controlled through increasing the water reserves in future while for the short term basis specifically Government must provision of the loans for tube well purposes and subsidies on the tube well machinery that each and every farmer an access to own tube well.

Agricultural bank which known the Zari Taraqiti Bank (ZTBL) must having the easy process to the farmers and provision of the credit on the easy terms and conditions and in time of need. So that they can purchase inputs in time of use such timely, provision of the inputs positively affects the cotton production and reduces the inefficiency of the farmers.

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