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Estimation of Productivity and Efficiency of Cotton Farmers in Pakistan: A Case Study of District Dera Ghazi Khan

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Abstract

This paper investigates technical, allocative and economic efficiency of cotton farmers of district Dera Ghazi Khan using data envelopment analysis technique. Structured questionnaire is used to collect the data of cotton farmers. Data collection is carried out for Kharif season of 2012. A stratified random sampling selection technique was used to collect the data. The results reveal that mean total technical, pure technical, allocative, economic and scale efficiencies are 0.67, 0.94, 0.57, 0.54 and 0.71 respectively. It also shows that cotton farmer can produce average 22.5 mounds per acre seed cotton without reducing the inputs and technology. It also concludes that education, experience and contact with extension workers are significant determinants of technical efficiency of the cotton farmers.

Keywords: Technical Efficiency. Allocative Efficiency, Economic Efficiency, DEA, Cotton

Introduction

Agricultural is a key sector in Pakistan. Its share in Gross Domestic Product (GDP) is 21.4 percent with absorption of 45 percent of labor force. Population residing in rural areas of country is directly or indirectly linked with agriculture sector, which is almost 60 percent of total population (GOP, 2012). The major crops of Pakistan are wheat, cotton, rice and sugarcane and these contribute 25.24 percent to entire agricultural sector. Cotton is the most important cash crop in Pakistan. It accounts for 7 percent in the entire agricultural sector. It is sown in 2879 thousand hectares[2]. In 2012, cotton production was predicted at 14 million bales (GOP, 2012).

Figure 1 shows different sector's share in GDP. The overall agriculture share in GDP decreased from 1960 to 2011 but still it is higher than manufacturing sector. In 1960 agriculture share in GDP was 46.2 percent and in 2011 it came at 21.6 percent (World Bank, 2013). The area of cotton increased in Pakistan over the last three decades but every time its yield has been threatened.

In developing countries majority of the population lives in rural areas and faces extreme poverty. Pakistan is one of those countries where the huge population is linked directly or indirectly with agriculture sector. In the agriculture sector cotton is the one of major cash

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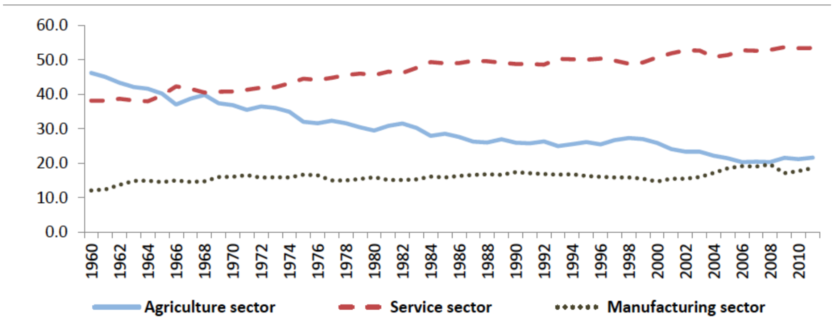
2 Hectare: one hectare is equal to 2.471 acres

crops in Pakistan. It is very important crop to earn the money and reduce the poverty level and in improving living standard in rural areas. But unfortunately cotton production has not improved significantly. Farmers practice subsistence and traditional farming with low productivity. "This may be attributed to higher inefficiencies (technical and allocative) because farmers have less access to resources and extension services to guide them for commercial production" Javed, et al. (2009). Cotton is also the most important and major crop of District Dera Ghazi Khan. Recently, cotton crop decreased 6.61 percent due to the some crop related and climate change problems.

Figure-1: Percentage Share of Different Sectors in GDP



Source: Pakistan Cotton Ginners Association.

Table-1 gives the cotton production of District Dera Ghazi Khan. It was 515000 bales in 2005-06 and 519000 bales in 2006-07. It was highest in 2006-07 and yet has not reached again up to this level. The condition of cotton production in Dera Ghazi Khan is similar to other districts of Punjab. According to the Directorate of Agriculture Crop Reporting Service, Punjab mostly increase in production is due to increase in planted area. It seems other factors have not major role. Such conclusions cannot be drawn until we assume that farmers are technically efficient.

Table-1: Cotton Production of District Dera Ghazi Khan

Years	Production In 000 Bales
2005-06	515
2006-07	519
2007-08	464
2008-09	233.18
2009-10	356.16
2010-11	212.50
2011-12	344.25

Note: Bale=170 KG
Source: Directorate of Agriculture, Crop Reporting Service, Punjab.

This study selected cotton crop to find total technical, pure technical, allocative, economic and scale efficiencies of its farmers. The efficiency indices computed will make known the extent of technical and allocative inefficiencies among cotton farmers. It would reflect existing potential for farmers to improve output without changing the combination of inputs or produce the same output with fewer inputs than they are currently using. Farm and farmer characteristics observed among efficient farmers will be used to formulate policy recommendations that will help policy makers to develop strategies that may help inefficient farmers. This will also be important in extension work as it will highlight farm and farmer characteristics more likely to enhance productivity among the farmers. It also analyzes the determinants of technical efficiency. Furthermore, it helps in understanding the core problems which are being faced by cotton farmers of District Dera Ghazi Khan. The other reason of selection of cotton crop is its importance in textile, food of animals and edible oil.

Literature Review

A number of studies are available in literature that present technical efficiency of cotton and other agriculture crops like wheat, sugarcane, tomato etc. Sohail, et al. (2012) estimates the technical efficiency for wheat production of district Sargodha, Pakistan. They use data envelopment analysis (DEA) methodology for estimation of efficiencies and Tobit regression to find out the determinants of efficiency. The study finds that efficiency varies from 0.6 to 1. It also examines dependence of efficiency on farm specific variable such as experience, education, villages distance, household size and farm size. The results show that farm size and village distance are negatively related with technical efficiency.

A similar study using DEA is conducted by Javed, et al. (2009) estimates technical, allocative and economic efficiencies of cotton and wheat farmers in Punjab, Pakistan. Result shows that average technical, allocative and economic efficiencies are 0.87, 0.44 percent and 0.37 respectively. It also indicates that farmers' education and extension agents are negatively related with inefficiency of cotton and wheat farming. Gul, et al. (2009) estimates the determinants of technical efficiency of cotton growing farms in Turkey. They use DEA methodology to find efficiencies and Tobit analysis to analyze the determinants of efficiency. Result shows that on average technical efficiency is 0.79. It means 21 percent capacity is available for increasing cotton production without changing inputs and technology.

Gwandi, et al. (2010) estimates efficiency of cotton production in Gassol local Government area of Taraba state, Nigeria. The stochastic frontier analysis (SFA) is used to determine technical, allocative and economic efficiencies. The result shows that 82 percent of the variation in output of cotton is explained by input factors. The farm size and family labour have negative impact. The result also shows that resources are over utilized in cotton production so farmers need more knowledge on input use. Sylvain, et al. (2010) also use the SFA to estimate determinants of the technical efficiency of cotton farmers in Northern Cameroon. The result gives technical efficiency indices vary from 11 percent to 91 percent.

Ogunniyi and Oladejo (2011) estimate the technical efficiency of tomato production in Oyo state Nigeria. The 150 random samples were collected by using multi-stage sampling technique.

The DEA methodology used to estimate technical efficiency and Tobit analysis used to determinants of efficiency. Result show that the technical efficiency varies 31 percent to 100 percent .The on average technical and scale efficiencies are 42 percent and 82 percent. The study also shows that there is small scale inefficiency due to excess use for all inputs especially for fertilizer, family and hired labor. The determinants of technical efficiency are education, experience, marital status and gender. Ebong, et al. (2009) estimates the determinants of technical efficiency of urban farming in Uyo metropolis of AkawaIbom state, Nigeria. A simple random sampling procedure was employed in the selection of 75 urban farmers from the four designated locations in the study area and Maximum Likelihood

Estimation (MLE) procedure was used. The SFA used to determents technical efficiency of urban farming.

The result shows that the coefficients of farm size, capital, labor and planting materials were all positive and significant with technical efficiency. According to the inefficiency analysis age, farming experience, education, extension contract and household size has influence the inefficiency of the farmer. The Farmers technical efficiency index varies 0.10 to 0.95 and with on average 81 percent.

Dlamini, et al. (2010) estimates the technical efficiency of small scale sugarcane farmers in Swaziland state, Africa. A stratified random sample size of 75 farmers was obtained. The well structure questionnaire used to collect the data. The result of SFA and inefficiency model indicated that elasticity of fertilizer variable for the VUVULANE small scale sugarcane farmers was higher 0.536 and the labour, herbicides were positive, age and land was negative influence. Overall technical efficiency mean is 73.6 percent to 86.7 percent. Hajian, et al. (2013) estimates the total factor productivity and efficiency in Iranian crop productivity through the data envelopment analysis. The study consists on the penal data of 1995 to 2009. The result shows that productivity rise in this period. Technical efficiencies level higher but allocative and economic efficiencies are in lower level.

On other hand, Abid, et al. (2011) conduct resource use efficiency analysis of small BT cotton farmers in Punjab, Pakistan by using Cobb-Douglas production function. They find that BT cotton production has an increasing return to scale with elasticity of production 1.16 of small farmers. All production inputs i.e. pesticides, irrigation; fertilizers and labour were underutilized because ratio of MVP/ MFC[3] was greater than unity i.e. 3.94, 2.01, 1.5 and 1.27, respectively.

In previous studies descriptive statistics analysis is used to describe socioeconomics characteristics of cotton farmers while the DEA and SFA are commonly used to analyze the productivity and efficiencies (technical, allocative and economic). These studies also show that the determinants of inefficiency of productivity and technical efficiency are estimated with the help of (Tobin, 1995) regression and Coelli, et al. (2005) model. These all studies help us in making the design of our study analysis.

Material and Methods

The Dera Ghazi Khan District is enclosed in the north by Dera Ismail Khan District of Khyber Pakhtoonkhwa (KPK) and its bordering Tribal Area, on the west by Musa Khel and Barkhan districts of Baluchistan Province, on the south by Rajanpur and on the east by Muzaffargarh and Layya.

Sample Size and Sampling Design

The District Dera Ghazi Khan was purposively selected for this study. The Dera Ghazi Khan consists of the 41 union councils. We dropped 7 urban union councils and one Sakhi Sarwar union council because cotton crop is not sown there because of arid area. A random sampling technique is used to select the union councils, 08 union councils are randomly selected from 33 union councils. Fifteen sample farmers from each union council are

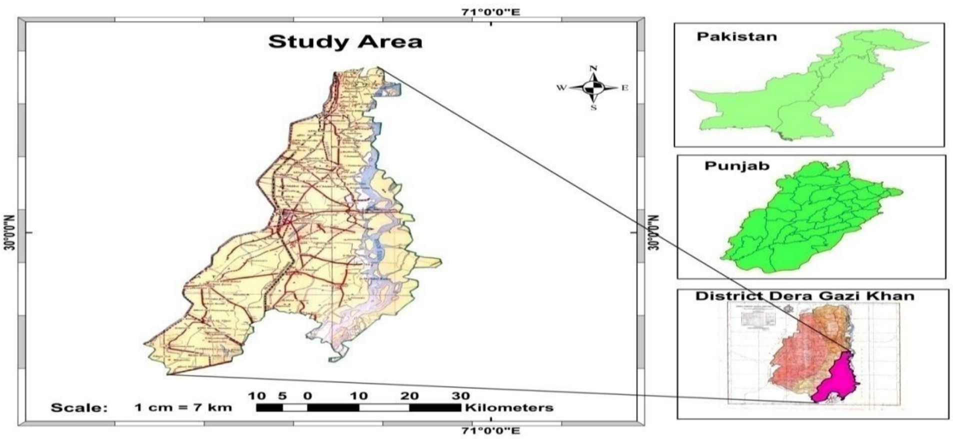
3 MVP is marginal value of product is the value of additional unit of input is equal to the price of output multiplied by marginal product of factor of production and MFC is marginal factor cost indicates how the total factor cost affected by one or more change in inputs.

selected from randomly selected villages based on the share of different categories. Total 120 farmers are interview by stratified sampling technique. The data are collected for the crop year 2012 (Kharif 2012). The cotton farmers are categorized as small, medium and large as given below:

1- Category (A): Small farmers 1 to 3 acres under cotton area

2- Category (B): Medium farmers 3 to 6 acres under cotton area

3- Category (C): Large farmers above than 6 acres under cotton area



Source: Survey of Pakistan

Data Limitation

This study has some weaknesses related to survey interviews; data accurateness is depended on respondent skill to remember earlier period information and to answer the survey questions. In district Dera Ghazi Khan, most of the farmers are illiterate and they do not keep the records of inputs and outputs. Therefore, after the first interview some information was again collected by re-interviewing the farmers to minimize the errors. However, some errors and inconsistencies are unavoidable in this kind of study.

Analysis

This paper uses the Data Envelopment Analysis (DEA) under assumption of Constant Return to Scale (CRS) and Variable Return to Scale (VRS) to estimate the technical, allocative and economic efficiencies and Tobit regression to find out determinants of technical efficiency.

Objective: $\mathrm{M}in_{\theta,\lambda}\theta$

Subject to: $-y_i + Y\lambda \geq 0$

$\theta x_i - X\lambda \geq 0$

$\lambda \geq 0$

Where:

θ represents the technical efficiency of ith farm

Y	represents output matrix for N farms
λ	represents Nx1 constant
X	represents input matrix for N farms
Y_i	represents the per acre cotton output of the ith farm in kilogram
X_i	represents the inputs vector of X_{1i}, X_{2i} . . . X_{8i}
X_{1i}	represents the crop area of the ith farm in acres
X_{2i}	represents the total quantity of seed per acre used on the ith farm in kilogram.
X_{3i}	represents the total quantity of nitrogen per acre used on the ith farm in kilogram.
X_{4i}	represents the total quantity of phosphate per acre used on the ith farm in kilogram
X_{5i}	shows the total tractor hours for all farm operations (which used in land preparation, weeding, planting, etc)
X_{6i}	represents the total quantity of pesticides per acre used on the ith farm in litre.
X_{7i}	represents the total number of irrigation per acre used on the ith farm in hours.
X_{8i}	represents the total labour (family and hired) as the total number of man-days[4] used on the ith farm.

To estimate the pure technical efficiency DEA is used following, Coelli, et al. (2005) with assumption of VRS:

Objective $\mathrm{M}in_{\theta,\lambda}\theta$

Subject to $-y_i + Y\lambda \geq 0$

$\theta x_i - X\lambda \geq 0$

$N1'\lambda = 1$

$\lambda \geq 0$

Where:

$N1'\lambda$ represents a convexity constraint which ensures that inefficient farm is only benchmarked against farm of a similar size.

This paper also uses DEA cost minimization method following Coelli, et al. (2005) with assumption of VRS for estimation of cost efficiency:

Objective $\mathrm{M}in_{\lambda,xi^E} wixi^E$

Subject to $-y_i + Y\lambda \geq 0$

$xi^E - X\lambda \geq 0$

$N1'\lambda = 1$

$\lambda \geq 0$

Where:

W_I is vector of input price W_{1i}, W_{2i}, W_{3i} . . . W_{12i} of the ith farm,

4 Man-day is a number of labor days while one day equals to 8 hours.

xi^E Is the cost minimizing vector of input quantizes for the ith farm,

N refers to total number of farms in the sample,

W_{1i} represents the per acre land cost of the ith farm in rupees,

W_{2i} represents the total cost of seed per acre used on the ith farm in rupees,

W_{3i} represents the total cost of nitrogen per acre used on the ith farm in rupees,

W_{4i} represents the total cost of phosphate per acre used on the ith farm in rupees,

W_{5i} shows the total cost of tractor hours for all farm operations (which used in land preparation, weeding, planting, etc.),

W_{6i} represents the total cost of pesticides per acre used on the ith farm in rupees,

W_{7i} represents the total cost of irrigation per acre used on the ith farm in rupees,

W_{8i} represents the total cost of labors family and hired as the total number of man-days used on the ith farm.

Cost efficiency is the ratio between the minimum possible cost and the observed cost.

$$CE = \frac{wixi^E}{wixi}$$

Allocative efficiency is estimated by dividing the cost efficiency with the technical efficiency.

$$AE = \frac{CE}{TE}$$

Scale efficiency is estimated by dividing the technical efficiency of constant return to scale and technical efficiency of variable return to scale.

$$SE = \frac{TE_{CRS}}{TE_{VRS}}$$

Scale efficiency score varies from zero to one, if scale efficiency equal to one indicate efficiency and less than one indicate inefficiency. The scale efficiency less than one due to increasing return to scale or decreasing return to scale and equal to one due to constant return to scale. *Technical, allocative, economic and scale efficiencies scores will be estimated by using the computer software DEAP 2.1.*

A second step regression model was applied to determine the farm specific attributes in illumination efficiency in this study. Alternatively, the factors can be integrated directly into the model and some external factors influence the technical efficiency of cotton farmers so in order to investigate these external factors. The study applied second step approach by using a Tobit regression.

$$E_i = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \beta_5 Z_5 + \mu_i$$

Where:

i represent the ith farm in sample,

E_i Represent the technical efficiency of the ith farm, i E

Z_1 Represents the education of the ith farmer in years of schooling,

Z_2 Represents the farming experience of the ith farmer in years,

Z_3 Represents the farm size of the ith farm in acres,

Z_4 Represents the access to extension services of the ith farmer in the cotton season,

Z_5 Represents the distance of the ith farm from main market in kilometers,

$\beta's$ are unknown parameters to be estimated,

μ_i is the error term.

GRETL computer software will be used to estimate Tobit regression model.

Results and Discussion

A review of key variables integrated in data envelopment analysis is given in Appendix table 1. The table is specified on per acre inputs quantities and per acre[5] cost basis. These results are calculated from 119 samples while one sample is dropped due to outlier. Total technical, pure technical, allocative, economic and scale efficiencies are presented in Appendix table 2 and table 2. The estimation gives 0.67 mean of total technical efficiency of sample farmer, which varies from 0.21 to 1.0. These results show that if sample farmer operate at full efficiency level they can reduce, on an average, their inputs use by 33 percent to produce the same level of output. Decomposition of technical efficiency shows that, on average, the sample farmers are more scale efficient than they are technically efficient. The mean pure technical efficiency of sample farmer is 0.94, which varies from 0.64 to 1.0.

The mean scale efficiency is 0.71, which varies from 0.26 to 1.00 and only 15 percent farmers are scale efficient while remaining 85 percent sample farmers are scale inefficient. Ninety-nine percent of these scale inefficient farmers operate under increasing returns to scale while remaining only 1 percent of these scale inefficient farmers operate under decreasing return to scale. The mean allocative efficiency of sample farmer is 0.57, with a minimum of 0.18 and a maximum of 1.00. The combined effect of technical and allocative efficiencies shows that mean economic efficiency of is 0.54, with a minimum of 0.17 and maximum of 1.00.

Table 2: Total Technical, Pure Technical, Allocative, Economic and Scale Efficiencies*

Efficiencies	TE_{crs}	TE_{vrs}	AE	EE	SE
Mean	0.67	0.94	0.57	0.54	0.71
Minimum	0.21	0.64	0.18	0.17	0.26
Maximum	1.00	1.00	1.00	1.00	1.00

* TEcrs mean technical efficiency through constant return to scale, TEvrs mean technical efficiency through variable returns to scale, AE mean allocative efficiency, EE mean economic efficiency and SE mean scale efficiency.

The results show that cotton farmers are not fully efficient. Therefore, if the farmers operate at full efficiency level they can reduce their cost of production by 46 percent without reducing the level of output and with the existing technology because their economic efficiency is 54 percent and allocative efficiency shows that the considerable room is available to enhance the productivity of sample farmers because 43 percent cost of inputs used in wrong direction and improve it. Frequency distribution of technical, allocative and economic efficiencies estimates of sample farmers in cotton system are given in figures 2 to 6 and Appendix table 1.

5 Acre: one acre is equal to 0.04046 hector.

It is evident from figure 2 that total technical efficiency of the sample farmers varies from 0.21 to 1.00. Most of the farmers' (63% out of 119) total technical efficiency is less than 0.80 while only 23 percent have more than 0.90. The situation seems different in case of pure technical efficiency (figure 3) here almost 90 percent farmers have pure technical efficiency more than 0.90. The pattern of allocative and economic efficiencies are alike (figure 4 and figure 5) with both average efficiencies around 0.55. Like other efficiencies the farmers are not scale efficient too (figure 6).

Figure 2: Frequency Distribution of Total Technical Efficiency

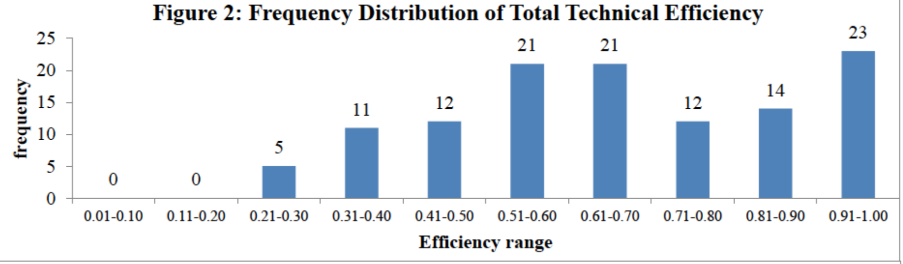


Figure 3: Frequency Distribution of Pure Technical efficiency

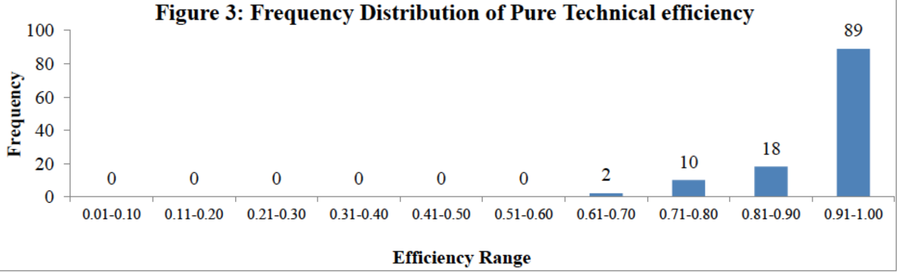


Figure 4: Frequency Distribution of Allocative Efficiency

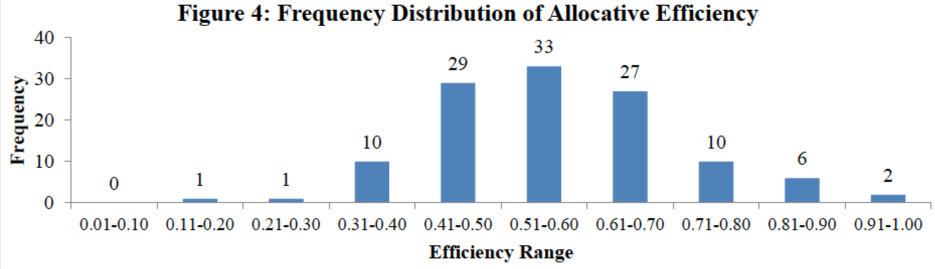
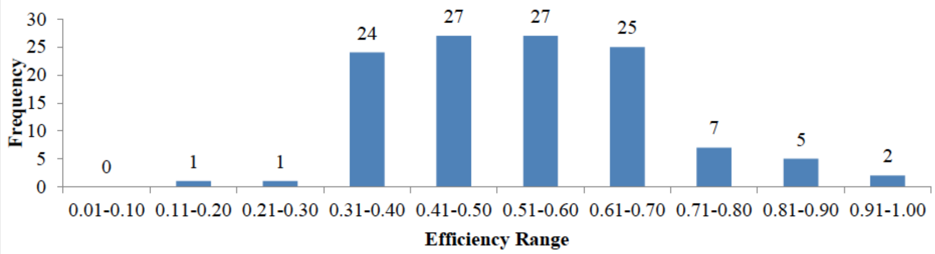


Figure 5: Frequency Distribution of Economic Efficiecy



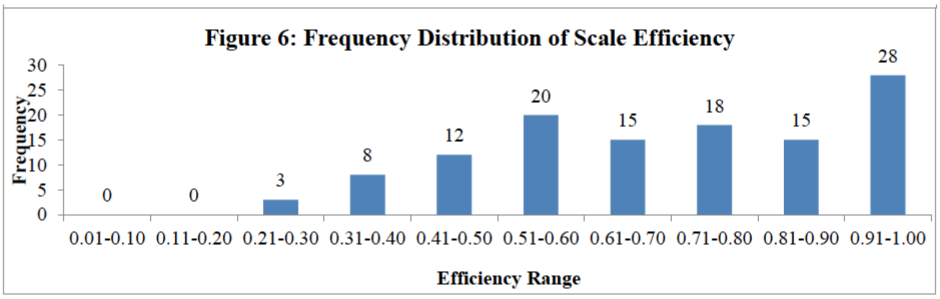


Table 3: Input Slacks and Number of Farmer Using Excess Inputs

Inputs	Number of Farmers	Mean Slack	Mean Input Use	Excess Input Use (%)
Cotton crop land in acres	13	0.70	6.91	10.09
Seed per acre in kg	15	0.15	5.96	2.58
Nitrogen per acre in kg	26	3.51	55.37	6.34
Phosphate per acre in kg	16	0.47	20.94	2.23
Per acre tractor hours	19	0.09	8.67	1.07
Pesticides per acre in litres	28	0.64	8.31	7.72
No of irrigation per acre in hours	34	1.92	13.15	14.59
Labor days per acre man-days	28	1.68	19.53	8.58

Input Slacks Analysis and Number of Farmers Using Excess Inputs

Table 3 indicates that input slacks and number of cotton farmers using excess inputs. It is evident that the farmers can reduce their cost on inputs by reducing the amount of slacks without reducing the output. Slacks are observed in irrigation, pesticides, nitrogen and labor. This is because farmers adopt traditional practices in using the inputs. They use inputs on the behalf of their father's, individual experience and illiterate pesticides shopkeeper advice. Therefore, it is most important to create awareness about new technologies and to give them training to improve the use of inputs.

Relationship between Efficiencies Estimates and Cropping Area

In order to investigated relationship among efficiencies and crop area. The crop area was categorized into three groups on the basis of operational holdings of farmers. Farm size A consists of 1-3 acres under cotton crop considered as small farmers, farm size B consists of 3-6 acres under cotton crop considered as medium farmers and farm size C consists of above 6 acres under cotton crop considered as large farmers. The total technical, pure technical, allocative, economic and scale efficiencies scores relative to the farm size in cotton crop are presented in table 4

The total technical efficiency, pure technical, allocative, economic and scale efficiencies of small sample farmers are 0.72, 0.96, 0.55, 0.53 and 0.75 respectively. The medium sample farmers have total technical, pure technical, allocative, economic and scale efficiencies are 0.65, 0.93, 0.61, 0.57 and 0.69 respectively. The large sample farmers have technical, pure technical, allocative, economic and scale efficiencies 0.62, 0.92, 0.55, 0.51 and 0.67 respectively.

Table 4: Means of Total Technical (TECRS), Pure Technical (TEVRS), Allocative, Economic and Scale Efficiencies Estimates according To Farm Size in Cotton crop

Categories	TEcrs	TEvrs	AE	EE	SE
A (1-3 acres)	0.72	0.96	0.55	0.53	0.75
B (3-6 acres)	0.65	0.93	0.61	0.57	0.69
C (up to 6 acres)	0.62	0.92	0.55	0.51	0.67

In the total technical, allocative, economic and scale efficiencies among cropping categories, category A farmers are more efficient than category B and C sample farmers and medium farmers are more efficient than category C farmers. The small sample farmers total technical, allocative, economic and scale more efficient than medium farmers because the small sample farmers use small unit, family labor, which all time work in field and proper management of small unit, less inputs required, easily control outside factor effect e.g. rain, weather. In the monsoon rain when the water stay in the field of cotton crop so the small unit of cotton crop easily drain and support to plant with different ways as compare to large and medium farm size.

Table 5: Scale share in categories, CRS (scale efficient), IRS (increasing return to scale) and DRS (decreasing return to scale) in Cotton Crop.

(in %)

Categories	CRS	IRS	DRS
A (1-3 acres)	20	80	-
B (4-6 acres)	15	83	2
C (more than 6 acres)	10	90	-

As presented in table 4 and table 5, scale efficiency of category (A) is 0.75. The 20 percent sample farmers are on constant return to scale while remaining is on increasing return to scale. It indicates that 80 percent of sample farmers need to increase operational scale to enhance the productivity and efficiency. While, medium farmers (category-B) having 0.69 scale efficiency. Among them only 15 percent are on constant return to scale and remaining 83 percent are on increasing return to scale. The large farmers (category-C) have scale is 0.67. The only 10 percent of sample farmers are on constant return to scale and 90 percent are on increasing return to scale. The results show that in all categories most of the farmers are on increasing returns to scale i.e. they can increase their output by changing their operational scale. It will also enhance their efficiencies.

Estimates of Target Output in Cotton Crop

This study also presents target output estimates based on output orientation methodology Table 6. This technique has an advantage of estimating the maximum possible production. The target refers to the amount of output the decision making units should aim at producing given the available unit of inputs and technology. The minimum output target that some of the decision management unit (DMU) should aim at producing the target output is 6.8 Mounds per acre. The maximum output target range is 36 Mounds per acre.

The average actual production is 16.46 Mounds per acre, but according to output orientation analysis the sample farmers can produce on average 22.5 mounds per acre without reducing or increasing their current level of inputs and technology. According to this analysis based on actual available inputs and technology to formers 10.9 percent out of total

119 sample farmers of cotton crop can produce the cotton seed range 6-10 Mounds per acre, 10.1 percent 11-15 Mounds per acre, 29.5 percent 16-20 Mounds per acre, 11.8 percent Mounds per acre, 14.3 percent 26-30 Mounds per acre and 23.5 percent more than 30 Mounds per acre, respectively.

Table 6: Frequency Distribution of Output Target in Cotton System (Mound=40kg)

Range	Frequency	Percentage
1.00-5.00	0	0.00
6.00-10.00	13	10.9
11.00-15.00	12	10.1
16.00-20.00	35	29.4
21.00-25.00	14	11.8
26.00-30.00	17	14.3
>30	28	23.5
Total	119	100.0

Analysis of Determinants of Technical Efficiency

The socioeconomic factors are expected to affect the level of technical efficiency of farmers. This study also makes an attempt to find out the sources of technical efficiency and external factors of cotton crop in District Dera Ghazi Khan. The Tobit regression model is used to estimate the determinants of technical efficiency and external factors. Table 7 shows that the coefficients of farmers education (schooling years), experience and contact with extension agents have positive signs as our priori expectations (positive related to technical efficiency) and significant. The educated farmers are more technically efficient than less/no years of schooling cotton farmers. The results are similar to Sohail, et al. (2012), Gul, et al. (2009) and Ali and Flinn (1989) argue that the educated farmers have better access to information, technology and standard inputs. Moreover, they can have effective dealing with financial issues. The experience is positive related and statistical significant which is the same explanation of the Bravo-Uretta (1994), Sohail, et al. (2012), Ali and Flinn (1989) and Abid, et al. (2011). It is indicating that farmers experience has an important effect on productivity and technical efficiency of cotton farming. The experienced farmer can manage the farming uncertainty and different practice in better way. The coefficient of contact with extension agents has positive and significant effect on the technical efficiency of cotton sample farmers. Result of this study is in the line with the result of Javed, et al. (2009) when farmers contact with extension agents then they get more information about modern farming, weather condition, cropping preparation, information about seeds, fertilizers and other requirements.

Table 7: Source of Technical Efficiency of Cotton System with Tobit Analysis

Variables	Coefficient	Std. Error	p-value
Constant	0.56***	0.07	0.00
Education	0.02**	0.01	0.04
Experience	0.003*	0.0017	0.09
Extension Workers	0.008*	0.005	0.08
Farm Size	-0.002*	0.001	0.05
Market Distance	-0.020**	0.008	0.01

Note: *** significant at 0.01level. **significant at 0.05 level.
* significant at 0.10 level

While the variable of farm size negatively related with the technical efficiency of cotton crop but coefficient is very small. However, on the basis of technology available to farmers of DeraGazi Khan bigger farm size can be a cause of low efficiency as proper management would not be easy. The most farmers used private Muzarey (labor) which are also illiterate and have financial constraints so they cannot properly manage the large unit. These situations create many problems for productivity and efficiency. The variable market distance is used as the proxy for development of road and market infrastructure. The distance from the village to main market of agriculture inputs and output is negatively associated with the technical efficiency. According to the (FAO, 2004) the purchasing of inputs would have been higher in a developing country if the supply of inputs available at the walking distance. The roads and market infrastructure is highly related with the agriculture production because the outputs are properly reached in market at the proper time and less destroy with hardship weather.

Conclusions

The present study was designed to estimate technical, allocative and economic efficiencies and also to investigate the determinants of technical efficiency of cotton farmers in District Dera Ghazi Khan. The data were collected for the crop year 2012 from 120 respondents, the one respondent drop due to outlier[6]. The Data envelopment analysis technique used to estimate the technical, allocative and economic efficiencies and the Tobit regression analysis was used to estimate the determinants of technical efficiency. Result derived from DEA models for the cotton crop farmers of District Dera Ghazi Khan indicated that mean total technical, pure technical, allocative, economic and scale efficiencies were 0.67, 0.94, 0.57, 0.54 and 0.71 respectively. Findings also uncovered that if farmers could manage optimal levels of inputs, they can reduce 33 percent inputs and 46 percent cost without changing level of output and technology because the technical and allocative efficiencies respectively, 67 and 54 percent. The small farmers are more technical, allocative and economically efficient than category-B (medium) and category-C (large) farmers The result of target output analysis shows that the sample farmers should produce on average 22.50 Mounds per acre output of seed cotton without reducing the inputs and technology while the actual output of seed cotton in this study was 16.46 Mounds per acre. The result of Tobit regression model shows that the education, experience, extension workers have positive collision on technical efficiency while impact of farm size and market distance was negative on technical efficiency of cotton crop.

Policy Recommendations

According to the finding there are some commendations, which enhance agricultural efficiency and productivity in District Dera Ghazi Khan.

1. The majority comprehensible consequence is that there is required of echo plan to encourage formal and technical education in rural area. This will allow the farmers to make better technical decision about the farming and best allocation of resources.
2. The study shows that farmers used excess inputs as traditional behavior, individual experience, believing their parents experience and the local village shopkeeper advice. The Government should make broadcasting strategy for awareness about the use of agriculture inputs and resources.

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6 One sample drop which farm area is 200 acres due to this standard deviation is greater in Appendix table 1

3. The study shows that the farmers having more contact with extension agents are more efficient than the farmers having low contacts. It is, therefore, recommended that the policy makers should focus on attractive farmers‟ access to information via provision of better extension services. Government should apportion more funds to make stronger the extension department and expending net of extension services in the remote areas.
4. The Government should make the strong policy to remove without licenses agro-shops, because mostly income of the illiterate farmers wastes into the flak seeds, fertilizers, pesticides and herbicides etc.
5. The study also shows that the farmers located near to the market are more efficient than the farmers located away from the market. It is, therefore recommended that the policy makers should focus on the development of market and road infrastructure supply outlets should be made closer to the farm gate.
6. The Government should issue the licenses to shops for purchase of cotton seeds at the prescribed rate by government. Further government can generate new revenue way in the form of license fee. This revenue can be used for the welfare of the farmers.
7. The Government should provide more funds for pakakhal system to save the canal irrigation water. Moreover, there should be proper monitoring by the agriculture department to check the quality of water, soil, fertilizers, seeds, pesticides and herbicides.

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APPENDICES

Table 1: Basic Statistics of Sample Farmers on Per Acre Basis in Cotton crop

Variables	Minimum	Maximum	Mean	Std. Deviation
Output per acre in kg	240.0	1440.0	657.10	223.0153
Total farm land in acres	1.0	200.0	10.40	19.3541
Land under cotton crop in acres	1.0	40.0	6.91	6.9563
Seed per acre in kg	3.8	10.0	5.96	1.6712
Nitrogen per acre in kg[7]	9.0	147.0	55.37	23.4862
Phosphate per acre in kg	4.6	69.0	20.94	7.5348
Per acre tractor hours	4.0	14.0	8.67	1.5490
Pesticides per acre in litre	1.5	18.1	8.31	3.1337
No. of Irrigation per acre in hours	4.0	32.0	13.15	7.3619
Labor days per acre man-days	4.5	57.0	19.53	11.2650
Per acre land cost in Rs	5000.0	20000.0	10263.03	2259.1758
Per acre seed cost in Rs	400.0	3000.0	1437.60	574.3237
Per acre nitrogen cost in Rs	684.8	11184.8	4220.16	1792.6342
Per acre phosphate cost in Rs	727.0	9945.7	3052.40	1093.8497
Per acre tractor hours cost in Rs	1200.0	4800.0	2825.63	664.3738
Per acre pesticide cost in Rs	2200.0	13000.0	7058.10	2058.3371
Per acre irrigation cost in Rs	910.0	10533.3	3067.01	1621.5261
Per acre labor cost in Rs	1350.0	17100.0	5858.15	3379.7743

Source: Field Survey by Author, 2012

Table 2: Efficiencies of Sample Farmers of District Dera Ghazi Khan

EFFICIENCY RANGE	TECRS		TEVRS		AE		EE		SE	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
0.01-0.10	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
0.11-0.20	0	0.0	0	0.0	1	0.8	1	0.8	0	0.0
0.21-0.30	5	4.2	0	0.0	1	0.8	1	0.8	3	2.5
0.31-0.40	11	9.2	0	0.0	10	8.4	24	20.2	8	6.7
0.41-0.50	12	10.1	0	0.0	29	24.4	27	22.7	12	10.1
0.51-0.60	21	17.6	0	0.0	33	27.7	27	22.7	20	16.8
0.61-0.70	21	17.6	2	1.7	27	22.7	25	21.0	15	12.6
0.71-0.80	12	10.1	10	8.4	10	8.4	7	5.9	18	15.1
0.81-0.90	14	11.8	18	15.1	6	5.0	5	4.2	15	12.6
0.91-1.00	23	19.3	89	74.8	2	1.7	2	1.7	28	23.5
TOTAL	119	100	119	100	119	100	119	100	119	100

7 Nitrogen and phosphate amount estimate from ratio of nitrogen in 50 kg bag.