Estimating the economic and production efficiency of cotton growers in Southern Punjab, Pakistan.

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Abstract

Considering the contraction of land under cotton cultivation in Pakistan due to low economic incentives, the present study is intended to estimate the cost and revenue along with different factors affecting the cotton production in southern Punjab. The primary data from 480 cotton growers was collected by adopting a multistage random sampling technique in person interviews by using a well-designed pretested questionnaire. The cost-benefit ratio was calculated by estimating the total production cost, total revenue, net farm income, and gross margins. The present study applied data envelopment analysis to evaluate the technical, allocative, and cost-efficiency of the cotton farmers. The second stage regression analysis was also conducted to explore the factor affecting cotton production by using the Cobb-Douglas production function. The regression results revealed that farming experience, education, land preparation cost, and irrigation cost has a positive impact on total revenue, whereas, chemicals and fertilizers cost showed a negative effect. According to BCR, medium farmers obtained 1.27 by investing one rupee in cotton production followed by large and small farmers 1.11 and 1.07, respectively. The results suggested that there is a dire need to fill the gap between extension workers and cotton growers. Moreover, the agriculture department should guide and train the farmers about the optimum utilization of inputs to reduce the production cost.

Keywords: Cost-benefit ratio. Economic Incentives. Cotton Cultivation. Agricultural Economics. Cobb-Douglas. Pakistan.

1. Introduction

The agriculture sector contributes the largest share of 18.5% to the country's gross domestic product and accommodates about 38.5% of the labor forces of the country (GOP, 2019). Cotton possesses a special status of the industrial cash crop in Pakistan, with an 8 % share to gross domestic product (SBP, 2019). Cotton is grown on 2.373 million hectors out of a total 23.30 million hectares of cultivated land in Pakistan (FAO, 2019). Pakistan is ranked as the world's 4th largest cotton producer and 3rd largest spinning industry in Asia (BCI, 2020). Cotton is the primary source of input to the textile sector that is the largest industrial sector of the country with employing 40 percent of the country's total labor force (DOA, 2019). Cotton and allied products are not only a key source of foreign exchange earnings but also a prominent source of livelihood; about 1.6 million farmers are growing cotton on the 15 percent of the nation's land (USDA, 2019).

Considering, cotton's massive economic contributions, it persists significant importance in the development of the rural sector of the country. Thus, the performance of cotton is a major factor of development not only for growers but also has a significant impact on the economic development of the country. Cotton contributed about 4.5% to agricultural value addition during the production year 2018-19 (GOP, 2019). Cotton is considered as a promising source of fiber all around the world, and cotton-seed provides edible oil to meet 64 percent of the nation's edible oil demand (Abid et al., 2011). Whereas, the byproduct of cotton seed that is known as seed cake is also an essential and healthy component of animal feed.

Despite being the 4th largest cotton producer, Pakistan is ranked as the 6th largest cotton importer in the world (Statista, 2020). The annual average cotton production is about 10.5 million bales, with an annual demand of 14 million bales (GOP, 2019). Thus, to meet the demand of its textile industry, the imports of raw cotton has significantly increased during the past six years (ICAC, 2019). The import of raw cotton was recorded highest with 4.2 million bales of worth 831.78 million dollars during the year 2019 (USDA, 2019). The major reason behind the rise in the reliance on imported cotton is due to the low average cotton yield per hectares. Pakistan cotton yield per hector in 2018-19 was ranked as 10th in the world due to the low average cotton production per hectare comparing with other competitive countries (Shahbaz et al., 2019). The significant reasons behind low cotton production are excessive use of inputs, shortage of water, insect, pests, and disease (DOA, 2019).

Among 1.6 million cotton growers in Pakistan, 81 percent are small farmers with landholdings of less than 5.7 hectares (USDA, 2019). Un-fortunately, large farmers in Pakistan have a significant influence in agriculture and have easy access to resources and modern technology (Kousar et al., 2006). Whereas, the small and medium farmers are facing archetypal constraints, i.e., resource availability, technical support, credit facility, and access to extension services. It is worth mentioning that expected prices drive farmers' planting decisions in addition to the factors such as relative cost of production from competing crops, input availability, and government support (USDA, 2019). The recent decrease in output and shift in farmer's decisions to plant other crops instead of cotton makes this research significant to investigate the farmer's economic efficiency and factors affecting the grower's revenue in the southern Punjab of Pakistan.

The main objective of the present study is to estimate the cost-benefit analysis of the cotton growers to calculate the returns on investments in this activity. The second objective of the present study is to evaluate the technical efficiency of the cotton farmers in the research zone by applying data envelopment analysis. Third, it is necessary to explore the major factor affecting the farmer's revenue to investigate the low cotton production per hectare by using the Cobb-Douglas production function. The fourth objective of the present research is to suggest pinpointed policy options to improve the profitability of cotton growers to address the low average cotton production.

The remaining of the paper is arranged as; the part second of the study discusses the literature reviewed. The third part briefly explains data, variables, and the methodology for empirical analysis of this study. The fourth part discusses the results and validates the results with other studies. The fifth part is consists of a conclusion followed by the references at the end.

2. Literature Review

Cotton being a universal source of textile input and due to its massive contributions to the world economy, became the topic of keen research for many researchers across the globe. There are plenty of studies that have been conducted with specific objectives in different countries such as; (Kumar et al., 2019) Estimated the technical efficiency of cotton production in Haryana district of India. Others researcher, i.e., (Tan et al., 2013) in China, (Solakoglu et al., 2013) in Turkey, (Karimov, 2014) in Uzbekistan, (Sarker and Alam, 2016) in Bangladesh and (Farias et al., 2002) conducted a study in Brazil.

Similarly, a lot of research studies had been conducted in Pakistan to suggest the policies to increase the productivity and profitability of cotton growers such as; (Rehman et al., 2019) used time-series data to investigate the economics perspective of cotton production. (Fatima et al., 2019) carried a study in Rahim Yaar Khan District to examine the impact of cotton on the efficiency of wheat crop. (Anwar et al., 2009) estimated the factor affecting cotton production in the Multan district of Pakistan. (Bakhsh et al., 2005) investigated the factors affecting cotton production in Sargodha, Pakistan. Whereas (Hameed and Salam, 2014) conducted a study in Dera Ghazi Khan to estimate the efficiency and productivity of cotton producers.

Although, literature is abundant that estimates the technical, economic efficiencies, or factors of inefficiencies in cotton production on the district level in Pakistan. But, based on the existing literature, no study was conducted to estimate the impact of different factors on cotton production, specifically in southern Punjab that is the largest cotton-producing region of the country (DOA, 2019). Thus, to address the main limitation of these studies and to explore the low average productivity of the cotton growers, the present study is indented to investigate the factors of cotton production in the southern Punjab of Pakistan. Moreover, the present study is unique to estimate the technical efficiency, economic efficiency, and cost-benefit analysis of cotton production to evaluate the returns on investment in cotton production.

The Cost-benefit ratio is an important tool to estimate the returns on investment. Therefore, plenty of studies have calculated the cost-benefit ratio for different crops to estimate the economic feasibility of the farmers, i.e., (Faisal et al., 2018a, Faisal et al., 2018b) estimated economic efficiency of tobacco growers in Pakistan. (Dalgic and Demircan, 2019) conducted economic analysis of sheep farming in Turkey. (Naeem et al., 2007) explored the profitability of sugarcane growers. (Gurmani et al., 2006) estimated the cost-benefit ratio of wheat, oat, and barley crops in Pakistan. (Srinivas et al., 2019) investigated economic analysis of maize adoption by applying cost-benefit analysis. (Sefeedpari et al., 2019) conducted the economic analysis of large dairy farming by using cost-benefit analysis. (Boz, 2019) conducted the cost analysis of cattle farming in Turkey. Thus, in line with the existing literature, the present study also calculated the cost-benefit ratio, gross margin, and net farm income to evaluate the economic viability of the cotton growers.

The Parametric and non-parametric model can be used to estimate the economics, technical and allocative efficiencies of the farmers. Many researchers, i.e., (Mohammadi et al., 2008, Kizilaslan, 2009, Mohammadi and Omid, 2010, Pishgar-Komleh et al., 2012) applied parametric models to estimate the technical efficiencies of different crops. Whereas; others such as (Işgın et al., 2020, Aydemir et al., 2019, Masuda, 2018, Parichatnon et al., 2017, Wagan et al., 2019) applied non-parametric model, i.e., data envelopment analysis to evaluate the efficiencies in different fields. Data envelopment is a non-parametric analysis. The DEA model classifies decision-making units (DMUs) by benchmarking the best (DMU). One of the main advantages of the DEA model is that it can simultaneously evaluate several outputs and inputs (Zhang et al., 2009). In addition to that, DEA does not require any predefine assumptions to make a functional relationship among inputs and outputs, which makes of DEA superior to other parametric models. (Mousavi et al., 2011a). Thus, keeping in view the vast application of DEA, the present study will also apply data envelopment analysis to calculate the economic efficiency of the cotton growers in Pakistan.

Moreover, the present study also conducted a second-stage regression analysis by applying the Cobb-Douglas production function. The C-D model was developed by Knut Wicksell and was statically tested by Charles Cobb and Paul Douglas in 1928 (Kumar et al., 2016). The C-D production function assumes that agricultural production depends on many exogenous and endogenous factors such as; fertilizers, labor, water, technical skills, and others (Nastis et al., 2012). Moreover, The Cobb-Douglas production function is superior to other models due to the easy estimation and interpretation of the results (Mahmood et al., 2012). Thus, many researchers used this model in agriculture to explore the factors of production for different crops such as; (Anwar et al., 2009, Yilmaz and Ozkan, 2004, Ashfaq et al., 2012, Bakhsh et al., 2014). Therefore, in line with the existing literature, the present study also used the C-D model to explore the major factors affecting farmer's revenue to explore the reason for low average return of investment in cotton production.

3. Materials and Methods

3.1. Research Zone

The Punjab province of Pakistan produces 80 percent of the total cotton produced in the country (Zulfiqar et al., 2017). The current study was carried out in four cotton-producing districts of Southern Punjab; Dera Ghazi Khan, Rajanpur, Khanewal, and Bahawalpur, keeping in view the total share of cotton production in Pakistan (BOS, 2019). The project zone is described in the attached study map.

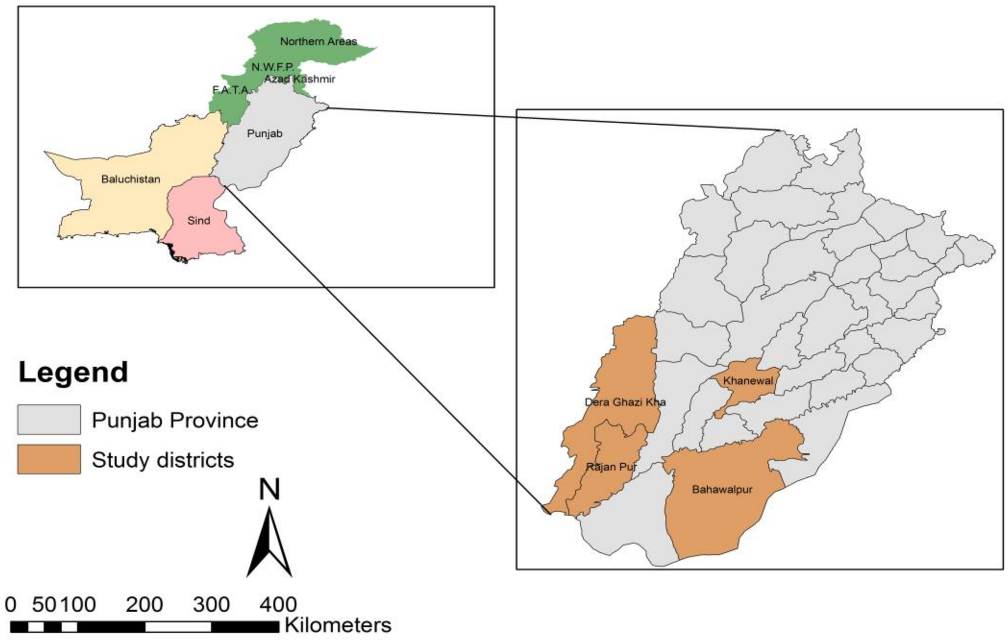

Figure 1: Research Zone.
Source: Designed by author

3.2. Sampling Methods

The data was collected by applying a multistage random sampling technique. The first stage, selection of Punjab province. In the next stage, district Dera Ghazi Khan, Rajanpur, Khanewal and Bahawalpur were selected. In stage third, cotton planting villages were selected. In last stage 20-25 cotton producers were selected from each village. Input-output information was collected from 480 cotton farmers in-person interviews. The farmers categorized as large, medium and small farmers with respect the landholdings. The farmers with landholding less than equal to 6.5 acres and 12.5 acres were declared as small and medium farmers, respectively. Whereas, the farmers with land holdings greater than 12.5 acres were declared as large farmers. Prior to the study, a pretest survey was carried out to test the scope of the area, sample, and instrument. The rain-fed fields were not included in the sample because of average low annual rainfall and, mainly, cotton is grown on irrigated land in the study regions.

3.3. Estimation of Costs and Returns

Different computers application were used to perform empirical analysis such as; Microsoft excel, Stat-14.0 and DEAP-2.1. To evaluate the economic efficiency of cotton farmers, total costs, total revenue was calculated. The total variable cost covers; seed, land preparation cost, total labor cost, irrigation cost, fertilizers and chemicals costs. Whereas; the fixed cost was reflected by taking land rent as the opportunity cost of the land (Faisal et al., 2018a). The benefit-cost ratio (BCR), gross margin (GM) and net farm income (NI) was carried out according to formulas given in equation no. 1,2, and 3 (Khan et al., 2017).

$$BCR = Total\ Revenue/Total\ cost \quad (1)$$

$$GM = Total\ Revenue - Variable\ cost \quad (2)$$

$$NI = Total\ Revenue - Total\ Cost \quad (3)$$

3.4. Data Envelopment Analysis

The production frontier was applied to evaluate the maximum productivity of the farmers by applying data envelopment analysis using DEAP-2.1 software. This model estimates the efficiency of the firms using inputs or outputs oriented models. The most of the agriculture-related studies consider the input-oriented method, the reason being the growers can only control the inputs but not the outputs (Wagan et al., 2018, Pahlavan et al., 2012). Therefore, this paper also used the DEA input-oriented model.

Furthermore, The DEA input-oriented technique works on two basic assumptions; (i) contact return to scale, (ii) variable return to scale (Coelli et al., 1998) suggested that DEA-CRS is more suitable when firms are operating at the optimum level. But, due to many constraint such as; farm size, financial crisis, credit facility, inputs availability makes it impossible for the farmers in Pakistan. Therefore, to mitigate these difficulties (Banker et al., 1984) presented the DEA variable return to scale method. Considering the objective and nature of the study, The DEA variable return to scale (VRS) method is used to evaluate the efficiency of the cotton farmers in the study zone.

The present study evaluated the farmer's efficiency scores using input-oriented DEA with the variable return to scale property. The variables to assess the efficiency scores are described as; the total output of each cotton grower was taken as output (Y) variable whereas, input variables include land preparation, seed rate, labor hours, fertilizers, chemicals, irrigation and land rent.

3.4.1. Technical Efficiency

The DEA-VRS input-oriented model was used to estimate the technical efficiency score of cotton growers as described by (Akram et al., 2019).

$min_{\theta,\lambda,}\theta$

Subject to: $-yi + Y\lambda \geq 0, \theta zi - Z\lambda \geq 0, \lambda \geq 0$ (4)

Whereas:

Y Shows the quantity of physical output for "N" cotton growers.
Θ represents technical efficiency.
λ represents Nx1 constant.
yi shows total revenue.
zi indicates vector of inputs of $X_{1i}, X_{2i}, X_{3i} \dots . X_{7i}$
Z indicates the physical quantity of inputs used.
Z_{1i} indicates the acres of the area under cotton.
Z_{2i} indicates the total machine hours.
Z_{3i} represents the seed rate.
Z_{4i} indicates the total labors hours.
Z_{5i} shows amount of fertilizers (kg).
Z_{6i} shows total irrigations hours.
Z_{7i} shows the liters of chemicals.

3.4.2. Economic Efficiency

The economic efficiency is defined as the minimum cost divided by actual cost and it can be evaluated by applying DEA cost-revenue model (Kumar et al., 2019). The DEA cost minimization model can be expressed as in Eq. (5).

$min_{\lambda,} xi^E, wi, xi^E,$

Subject to: $-yi + Y\lambda \geq 0,\ xi^E - X\lambda \geq 0,\ N1\lambda = 1, \lambda \geq 0$ (5)

Whereas:

wi Shows the price of input vectors $w_{1i}, w_{2i}, w_{3i} \dots . w_{7i}$.
xi^Eshows the cost minimizing quantity of input vectors.
N indicates the total numbers of cotton farmers.
w_{1i} represents the land rent.
w_{2i} indicates cost of machine operations, w_{3i} indicates the seed cost.,
w_{4i} indicates the labors cost, w_{5i} indicates fertilizers cost.

w_{6i} shows irrigations cost, w_{7i} shows chemicals cost.
Economic efficiency = minimum cost / actual cost

$$EE = wixi^{E}/wixi \quad (6)$$

3.5. The Cobb-Douglas Production Function

The second stage regression analysis was conducted for robustness by using the Cobb-Douglas production function. The present study applied the logarithmic form of the Cobb-Douglas model for easy estimation of the coefficients in linear form (Beattie et al., 1985). The detailed C-D model is presented in eq. no. 7

$$lnY = \alpha + \beta_1 lnX_1 + \beta_2 lnX_2 + \ldots\ldots\ldots.\ldots + \beta_9 lnX_9 + \cup_i \quad (7)$$

Whereas;

Y = Average revenue (PKR)
X_1 = Total labor cost,
X_2= Land preparation cost,
X_3= Seed Cost,
X_4= Irrigation Cost, X_5= Fertilizers Cost
X_6= Chemical Cost, X_7= Farmers Age,
X_8= Farming Experience, X_9= Education
α = Constant term
$\cup_i$ = Error term representing the impact of unexplained factors
$\beta_1 \ldots..\beta_9$ are the coefficients of estimation
ln = Natural Logarithm

4. Results and Discussion

4.1. The average cotton cost of Production acre^{-1}(PKR)

Table 1 presents the average variable cost of cotton production for small, medium and large cotton farmers in southern Punjab, Pakistan. Average total cost acre^{-1} was noted to be highest for small farmers with 64313.20 PKR/acre followed by large and medium farmers 63812.57 and 61855.11 PKR per acre, respectively. The small farmers in the project area paid more as compared to large and medium farmers especially, for seed purchase, irrigation charges, picking and loading cost. Moreover, small farmers also paid more labor cost incurred in seed sowing, fertilizer applications, hoeing and manual ridging.

The findings of the present study are in line with other studies such as; (Anwar et al., 2009) reported that small farmer paid the highest cost per acre for cotton production followed by large and medium growers in Multan District of Pakistan.

Table 1: Average Cotton cost of production Acre^{-1} (PKR)

Production Costs	Farmers Groups			Standard Error of mean
	Small 0-6.5	Medium 7-12.5	Large 12.5+	
Seed Sowing Labor Cost	2173.46	1903.37	1958.75	82.37
Manual ridging Labor cost	110.25	91.75	90.03	6.47
Fertilizer and FYM application Cost	530.52	451.30	438.01	28.88
Gap filling charges	381.00	311.00	261.00	34.80
Pesticide insecticide application charges	2210.15	2285.51	2226.83	22.85
Total Hoeing Charges	102.87	87.82	83.49	5.87
Labor cost of water course lining and irrigation	1111.15	1245.72	944.27	87.19
Picking, tying & loading Costs	3476.78	3334.89	3360.58	43.65
Stick uprooting cost	835.70	939.93	682.11	74.88
Total Labor Cost	**10932.00**	**10651.29**	**10045.07**	**261.72**
Seed cost	2755.55	2681.62	2522.72	68.69
Total Land Preparation Cost	5260.05	5385.17	5006.77	111.30
Total Fertilizer and FYM Cost	7278.89	7372.06	7681.25	121.60
Total Chemical Cost	4389.02	4695.95	4358.97	107.67
Total Irrigation Cost	9865.72	8321.72	9363.16	454.67
Opportunity cost of land	23831.97	22747.20	24834.63	602.74
Total Cost	**64313.20**	**61855.01**	**63812.57**	**750.01**

Author's tabulations
PKR stands for Pakistan Rupee.

4.2. Estimation of cost and returns in cotton cultivation

Table 2 shows the per acre economic analysis of cotton cultivation in the project zone. The results indicate that, on average, the medium farmers received the highest price of 3557.17 PKR/40kg with the highest yield of 32.41 40kg acre^{-1}. The medium farmers had the highest revenue (117821.08 PKR/acre) followed by large and small farmers 106392.80, 110376.08 PKR/acre, respectively. Moreover, the benefit-cost ratio (BCR) was noted to be highest for medium farmers 1.27 and followed by large farmers 1.12 and lowest for the small farmer 1.02. The results in table 2 indicate that small farmers were getting 1.02 by investing 1 rupee, which means that small farmers were the most vulnerable group with the lowest value of BCR, net income, and gross margin.

The results of the present study well agree with the existing literature, such as; (Khan et al., 2011) reported that small farmers were getting the least returns on cotton production in Multan and Bahawalpur with 1.22 BCR, followed by medium and large farmers.

Table 2: Economic Analysis of cotton production

Production Practices/Costs	Sub-Groups			Standard Error of mean
	Small	Medium	Large	
Cotton Production (40 kg/acre)	29.52	32.41	30.66	0.84
Average Price (Rs. /40kg)	3515.40	3557.17	3509.96	14.91
Stick Production (40 kg/acre)	33.34	31.48	34.99	1.01
Stick Price (Rs. /40kg)	78.53	80.47	78.90	0.59
Total Revenue (Rs.)	**106392.80**	**117821.08**	**110376.08**	3349.13
Total Cost (40 kg/acre)	64313.20	61855.01	63812.57	750.01
Gross Margin (Rs.)	65911.57	78713.27	71398.14	3708.08
Net Income (Rs.)	42079.60	55966.07	46563.51	4091.64
BCR	**1.02**	**1.27**	**1.12**	

Author's tabulations

4.3. Descriptive statistics of the Variables for Data Envelopment Analysis

Table 3 despites the variables used for the estimation of economic, technical, and allocative efficiency of the cotton growers with respect to their farm holdings using non-parametric data envelopment analysis. The results in table 3 show that the application of agricultural inputs varies across the sample due to different farm size holdings, technical skills, and financial conditions of the cotton growers in the research zone. According to the finding of the present study, the average yield of cotton is noted to be 63.99 mounds. In monetary terms, the average land rent was paid 23788.13 PKR per acre. Whereas, variable costs such as land preparation, seed, irrigation, fertilizers, and chemical cost are noted to be 5226.09 PKR, 2667.25 PKR, 9256.92 PKR, 7421.04 PKR and 4473.23 PKR per acre, respectively. Cotton is considered as one of the most labor-intensive crops due to extensive labor requirements for plantation, hoeing, application of fertilizers and chemical spry, picking, and others. The statistics in table 3 depicts the high cost of labor hired for different farm operations in cotton production is noted to be 9606.02 PKR.

Table 3: Descriptive statistics of the variables used in DEA Model

DEA variables	Units	Mean	SD	Min.	Max.
Cotton Yield (Cotton plus Sticks)	Mounds	63.99	5.74	46.00	76.00
Land under Cotton	Acre	9.74	7.23	0.50	45.00
Labor	Hours	124.39	42.14	42.00	**278.00**
Farm Machinery	Hours	6.18	2.50	2.00	20.00
Seed	Kg	5.20	1.15	2.80	7.50
Irrigation	Numbers	9	3	6	19
Fertilizer	Kg	156.67	55.88	75.00	250.00
Chemical	Liters	7.78	2.15	3.00	14.00
Input Cost and Output					

Opportunity Cost of Land	PKR	23788.13	4090.69	14300.00	34450.00
Labor Cost	PKR	9606.02	2500.69	3160.00	19950.00
Land preparation Cost	PKR	5226.09	1071.14	2200.00	8300.00
Seed Cost	PKR	2667.25	930.01	1115.00	4000.00
Irrigation Cost	PKR	9256.92	3101.87	4200.00	19550.00
Fertilizer cost	PKR	7421.04	2730.59	1900.00	13800.00
Chemical cost	PKR	4473.23	2040.29	1200.00	13800.00

Author's tabulations

4.4. Technical and economics efficiency scores

Table 4 presents the average technical, allocative, and economic efficiency scores obtained by DEA. The results in table 3 show that the average technical efficiency score of cotton farmers is noted to be 90%, with a maximum 100% and a minimum 52.0% efficiency level. These results stats that by operating on the efficient technical level, the cotton farmers can save about 10% of the inputs without effecting the cotton output and keeping the technology unchanged. The findings indicate that only 58.33% of cotton farmers were operating above 90% of the efficient technical level. Whereas, about 41.25% of the farmers were noted to be technical inefficient and were working between the technical efficiency level of 60% to 90%.

The results in the present study show that the average score of economic efficiency of cotton farmers is noted to be 53%, with a maximum 100% and a minimum 29%. These findings stats that about 47% of the economic efficiency of the farmers can be improved by keeping the output and technology unchanged. There are only 9% of the farmers were above 90% economically efficient, while 45.21% of cotton farmers had less than 50% of the economic efficiency level. These findings reveal the vulnerability of the cotton growers in the project zone. The allocative efficiency score of the cotton farmers on average is 59%, with a maximum 100% and a minimum 32%. These findings stats that cotton farmers can reduce the cost up to 41% by improving the allocation of the inputs.

Table 4: Efficiency Distribution of Cotton Growers

Efficiency Range	Technical efficiency		Allocative efficiency		Economic efficiency	
	N	%	N	%	N	%
E≤0.5		0	112	23.33	217	45.21
0.5<E≤0.6	2	0.42	175	36.46	130	27.08
0.6<E≤0.7	23	4.79	116	24.17	66	13.75
0.7<E≤0.8	57	11.88	49	10.21	42	8.75
0.8<E≤0.9	118	24.58	19	3.96	16	3.33
0.9<E≤1.0	280	58.33	9	1.88	9	1.88
Total	**480**	**100**	**480**	**100**	**480**	**100**
Mean	0.90		0.59		0.53	
Minimum	0.53		0.32		0.29	

Maximum	1.00	1.00	1.00
Sd.	0.10	0.12	0.13

Author's tabulations

These findings can be justified with exiting literature such as (Hameed and Salam, 2014) reported that the average technical efficiency score of cotton growers in Dera Ghazi Khan was 94% with a maximum value of 100.% and minimum 62% efficiency level. Similarly, the average economic efficiency was noted to be 54%, with a minimum value of 17%. The average allocative was 57%, with a minimum value of 18%. The results of the present study are also in line with the other studies such as (Khan and Ali, 2013, Faisal et al., 2018a, Bozoğlu and Ceyhan, 2007).

4.5. Efficiency distribution with respect to farm size

The results in Table 5 reveals that the technical efficiency score was highest 90.9% for small farmers, followed by large and medium farmers with 89.9% and 89.7%, respectively. The allocative efficiency score reported to be highest for small farmers and then followed by large and medium farms. The economic efficiency of the large farmers was noted to be 56.1%, and whereas, for medium and small cotton farmers were noted to be 54% and 54.6%, respectively. The findings of the present study can be justified with the results of other studies, i.e., (Faisal et al., 2018a) reported that small and medium farmers were economically inefficient in Rajanpur and D.G. Khan. The comparatively low economic efficiency of the small and medium farmers is an important indicator of their vulnerability, and the majority of the farmers belong to the small farming group in Pakistan.

Table 5: Average efficiency score of Cotton Growers

Particular	Farmer's Group		
	Small	Medium	Large
Technical Efficiency	0.909	0.897	0.899
Allocative Efficiency	0.594	0.609	0.576
Economic Efficiency	0.54	0.546	0.561

Author's tabulations

4.6. The Factor Affecting the Revenue of the Cotton Growers

The second stage regression analysis was conducted by applying the Cobb-Douglas production function to investigate the impact of different factors on total revenue to probe the core cause of low economic incentives of cotton production in southern Punjab, Pakistan.

Table 6 presents the adequacy of the regression analysis on the bases of the obtained values of R^2 (59.41), Adjusted R^2 (57.49), and F statistics (32.47). The results of the present study indices that education, farming experience, irrigation cost, and land preparation cost has a positive impact on total revenue. The regression coefficient for education is significant and positive, which indicates that the total revenue can be increased by 0.003%, adding one year of schooling. The educated farmer has the ability to better understand the production technology and can easily adapt the better farm management practices. The results of the study in hand for the impact of education on revenue can be compared with the exiting studies such as (Khan and Ghafar, 2013, Khan et al., 2017). In addition to that, the results in table 6 exhibit that 1 % increase in land preparation cost, irrigation cost and farming experience led to an increase in revenue by 9.8%, 3.4%, 1.9%, and 1%, respectively. These findings can be justified with (Khan et al., 2017). The results also depict that the total revenue was decreased by 1.1% due to a one percent additional application of the pesticides and chemicals. These findings suggest that cotton growers are applying an excessive amount of the chemicals which not only have a negative impact on their economic incentive but also had a worse impact on farmer's health and environment.

Table 6: Factors Affecting the Revenue of Cotton Growers

Variable	Coefficient	Sd. Error	t-value	p-value
Total Labor Cost	0.077	0.029	2.660	0.008***
Land preparation Cost	0.098	0.035	2.810	0.005***
Seed Cost	0.009	0.022	0.410	0.068***
Irrigation Cost	0.034	0.024	1.380	0.017***
Fertilizers Cost	0.019	0.023	0.820	0.413
Pesticides Cost	-0.011	0.017	-0.660	0.051**
Farmers Age	0.020	0.040	0.500	0.616
Farming Experience	0.010	0.020	0.490	0.063**
Education	0.003	0.002	1.600	0.011***
Constant	9.544	0.543	17.560	0.000
R^2	59.41			
Adjusted R^2	57.49			
F Ratio	32.47			

*** P-value represents 1 % significance level of the β coefficients.
Author's tabulations

5. Conclusion

Although cotton cultivation is a profitable process but, the small cotton farmers are the most vulnerable group, and they are earning the least as compared to large and medium farmers. The core barriers behind the low economic incentives in cotton production for the small and medium farmers are excessive use of inputs, price instability, expensive and low quality of inputs, high middle man margin, the lake of access to agriculture extension services, disease, and pest attacks. Moreover, the complicated agricultural credit facility forces small farmers to purchase expensive inputs from informal credit sources. The cost-benefit ratio indices that small farmers incurred the highest cost of cotton production due to excessive application of pesticides, costly fertilizers, and rented machines. The cost-benefit ratio also indicated that small farmers were getting the least returns on investments in cotton production.

The findings of the present research contribute to the existing literature by indicating that the farmers were applying excessive chemicals to fight disease and pest attacks, which ultimately leads to an increase in the cost of production and reducing the farmer's revenue. Thus, the government should introduce farmers with advanced techniques to efficiently control pests and disease attacks. Moreover, extension agents should provide training to the farmers for the optimum use of inputs by adopting better management practices. The government should regulate and impose check and balance on the informal credit sources so that farmers can get input on market rates. Moreover, the government should introduce some informal online markets and provide farmers with training to sell the produce online to the buyers to minimize the role of middle man to increase the farmer's revenue. Whereas, the quality control department should monitor the quality of inputs, i.e., chemicals, fertilizers, and seeds. There is a dire need that the government should control the price of various inputs such as; chemical, seed, fertilizers and electricity.

Concluding that the study finds that along with inefficient use of agricultural inputs other characteristics such as; the lake of agriculture credit, extension services, low formal education, farming experience and high middle man margins are also the major cause of less cotton yield, generating less revenue and getting less returns on investment. These low economic incentives is one of the most important reasons behind contraction land under cotton cultivation.

Although, the current study provides key insights for policymakers to increase the productivity of cotton and stop farmers from quitting cotton plantation by suggesting how to enhance farmer's revenue? And how to increase farmer's economic incentives? But, the current study did not consider the economic stimulus from the competing crops in the analysis, which is the main limitation of the study. Therefore, future research is planned to evaluate the impact of competing crops economic incentives on farmer's decision to quit cotton plantation.

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