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### ECONOMIC ANALYSIS OF OPEN FIELD CHILLI (*Capsicum annum* L.) PRODUCTION IN PUNJAB, PAKISTAN

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#### KEYWORDS

Benefit cost ratio

Cobb-Douglas

Gross income

Net income

Vegetables

#### ABSTRACT

Vegetable are a basic component of food security and necessary to meet the increasing food demand of increasing population. Present study was designed to explore the cost, revenue and modeling of revenue with different inputs in open field capsicum/bell pepper production in Punjab, Pakistan. Total 70 respondents were interviewed with stratified random sampling in 2014. Total cost (Rs. 277,064.82) was higher for small farmers and it was followed by large (Rs. 258,178.11) and medium (Rs. 256,496.42) farmers. Total production (21,209.27 kg acre<sup>-1</sup>), average price (Rs. 25.33 per kg) and revenue (Rs. 537,264.67 acre<sup>-1</sup>) were higher for small farmers. According to BCR, medium farmer received Rs. 2.02 by investing rupee one in this activity followed by small (Rs. 1.94) and large (Rs. 1.70) farmers. Result showed a positive impact on revenue due to education, experience in capsicum production, extension services and labor cost. The revenue coefficient was negative for land preparation and chemical cost. Model was appropriate according to R<sup>2</sup> (0.707) and f-value (16.006). Unstable prices, less extension services, disease attack and impure inputs were main problems. Government should eliminate these problems and improve the technical knowledge/training of farmers. Government should ensure the quality of agricultural inputs such as fertilizers, sprays and seed.

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## 1 Introduction

Agriculture occupied a major (20.9%) share in the gross domestic product of Pakistan with the involvement of 43.5% labor force (Government of Pakistan, 2016a). Total cropped area was 23.40 million ha in Pakistan (Muhammad et al., 2015) but vegetables occupied only 0.386 million ha in the production of total 3116808 tones vegetables (Government of Pakistan, 2016b). There exists 2.18% increase in per capita monthly vegetable consumption from 4.13 kg (2011-12) to 4.22 kg (2013-14) in Pakistan (Government of Pakistan, 2015a). Export of fruits, vegetables and condiments increases 9.17% from Rs. 2366.48 billion (2012-13) to Rs. 2583.46 billion (2013-14) while import of these items increases by 0.29% from Rs. 4630.52 billion (2013-14) to Rs. 4644.15 billion (2014-15) (Government of Pakistan, 2015b & 2016b). It showed the deficit in the trade of vegetables, fruits and condiments in Pakistan.

Capsicum (*Capsicum annuum* L.) is a popular vegetable crop, commonly known as bell pepper or sweet pepper or hot pepper or chilli. It was consumed as a spice, vegetable, pickle, condiment and sauce. Internationally, chillies are consumed as a spice and become an ingredient in medicines and beverages (Daundkar & Bairagi, 2015; Velayutham & Damodaran, 2015). Green chillies provide proteins, minerals, vitamin A and C while dry chillies are known as a source of vitamin A and D (Patel, 2014).

International area under chilli production was 19.89 million ha with a production of 33.52 million tonnes (Patel, 2014). Among various chilli grown countries, India (13 million tones or 38.78%) is the largest chilli producing country and it was followed by China (3 million or 8.65%) (Patel, 2014). In case of productivity (tons/ha), China occupied first position (6.74 tons/ha) and it was followed by Pakistan (2.31 tons/ha), Tailand (2.23 tons/ha), Mexico (1.85 tons/ha), Bangladesh (1.74 tons/ha), Nigeria (1.72 tons/ha), World (1.68 tons/ha), India (1.64 tons/ha), Vietnam (1.45 tons/ha), Myanmar (0.97 tons/ha) and Romania (0.87 tons/ha), this things shows the potential of chilli production in Pakistan (Patel, 2014).

But, the area under chilli production was decreased by 2.68% from 64,175 ha (2007-08) to 62,456 ha (2014-15) in Pakistan. Irrespective of that fact, total production of chilli showed a tremendous increases (20.32%) from 11,101 tonne (2007-08) to 139,687 tonnes (2014-15) within 8 years (Government of Pakistan, 2013; Government of Pakistan, 2016b). It showed 23.62% increase in the yield from 1809.13 kg ha<sup>-1</sup> (2007-08) to 2,236.5 kg ha<sup>-1</sup> (2014-15) which showed its growth in Pakistan. On the other hand, area under chilli production was increase by 12.83% from 5121 ha (2007-08) to 5,778 ha (2014-15) in Punjab. Similarly, total chilli production was increased 15.93% from 8,087 tonnes (2007-08) to 9,377 tonnes (2014-15) while yield was increased 2.77% from 1,579.18 kg ha<sup>-1</sup> (2007-08) to 1,622.88 kg ha<sup>-1</sup> (2014-15). It reflects the

popularity of chilli production in Punjab (Government of Pakistan, 2013; Government of Pakistan, 2016b).

Punjab province is located between 24-37°N and 62-75°E in the fertile land of five south flowing rivers (Farooqi et al., 2007). Region is blessed with a good climate, suitable for vegetable production in open field and tunnel farming (Muhammad et al., 2015). In 2012-13, top ten leading vegetable producing areas were Gujranwala (11463 ha) followed by Faisalabad (9489 ha), Sheikhpura (9076 ha), Okara (7914 ha), Sahiwal (7728 ha), Khanewal (7288 ha), Kasur (6700 ha), Lahore (5745 ha), Rahimyar Khan (5587 ha) and Toba Tek Singh (4642 ha) (Government of Pakistan, 2015c).

Due to its importance, a fine literature is available about the economic analysis of capsicum production especially in India. But literature was not satisfactory about the economic analysis of capsicum in Punjab, Pakistan. Therefore, a comprehensive study is required about the economic analysis and modeling of output and inputs in open field capsicum production.

In a study, Sanusi & Ayinde (2013) designed the study to investigate the profitability in pepper production in Nigeria. The mean of different socio-economic characteristics were estimated such as age (43 years), pepper growing experience (12 years), family size (8 persons) and farm size (1.23 ha). On average, the variable and fixed cost were N 228,293.06 (US\$ 1,521.95) and N 9,765.49 (US\$ 65.10), respectively to receive the average revenue of N 622,847.56 (US\$ 4,152.32). The return to investment ratio was 2.62.

Similarly, Olayiwola (2014) performed the economic analysis of chilli production in Nigeria. On per acre basis, total cost was estimated for small (34,225.05 Naira), medium (38,612.48 Naira) and large (42,086.84 Naira) farmers. The gross income was higher for large farmers (73,883.49 Naira) and less for small (49,104.38 Naira) farmer. Similarly, large farmers had higher benefit cost ratio (1.91) as compared with medium (1.87) and small (1.56) farmers.

Recently, Daundkar & Bairagi (2015) explored the economics of capsicum in India. Total cost was Rs. 125,260 with net returns (Rs. 273,388) and input-output ratio (3.11). Velayutham & Damodaran (2015) demonstrated the economic performance of chilli production in India. Regression coefficients of Cobb-Douglas model were positive for labour man-days (0.406), manure (0.0778), fertilizer (0.368) and chemicals (0.251).

In the light of above facts, present study was aimed to estimate the total production cost, total revenue, benefit-cost ratio, gross margin, net income and determinant of revenue in open field capsicum production.

## 2 Materials and Methods

This study was based on primary data, collected from 70 open field capsicum growers in 2014 from districts Faisalabad and Toba Tek Singh, Pakistan. For large size population, a sample of 60 respondents was appropriate for better results (Poate & Daplyn, 1993; Mari, 2009). Stratified random sampling was adopted because it was helpful when total population was distributed into various sub-groups and a sample was taken from each sub-group on random basis (Teddle & Yu, 2007). Respondents were divided into three sub-groups such as small, medium and large farmers. Total operational land was less than 12.5 acres for small farmers; more than 25 acres for large farmers; and between 12.5 and 25 acres for medium farmers (Hassan et al., 2005). Small, medium and large farmers were 44.3%, 30.0% and 25.7%, respectively for present study.

### 2.1 Estimation of costs and returns

For economic analysis, total revenue (TR) and total cost (TC) were estimated in open field capsicum production. Total variable cost was calculated by the addition of cost incurred on land preparation, seed, transplantation, fertilization, earthing up, hoeing, irrigation, pesticides, picking and marketing. Total fixed cost was the sum of land rent (six months), administration charges, interest on variable cost (Mwangi, 2012) and abyana (Noonari et al., 2015). An interest rate of 8% was also applied for empirical analysis.

Benefit-cost ratio, gross margin and net income were calculated with given formulas (Ali et al., 2016):

#### 2.1.1 Benefit Cost Ratio (BCR)

BCR is obtained by dividing total revenue (TR) with total cost (TC). It explains the amount of revenue for the investment of one rupee as total cost.

$$BCR = \frac{TR}{TC} \text{ --- (1)}$$

#### 2.1.2 Gross Margin (GM)

It is obtained by subtracting variable cost (VC) from total revenue (TR).

$$GM = TR - VC \text{ --- (2)}$$

#### 2.1.3 Net Income (NI)

It is obtained by subtracting total cost (TC) from total revenue (TR).

$$NI = TR - TC \text{ --- (3)}$$

### 2.2 One-way analysis of variance (ANOVA)

ANOVA explored the difference in the mean values for various sub-groups (Ostertagová & Ostertag, 2013) by using following null and alternative hypothesis:

$$\begin{aligned} \text{Null hypothesis } H_0: & \mu_1 = \mu_2 = \mu_3 \\ \text{Alternative hypothesis } H_1: & \mu_1 \neq \mu_2 \neq \mu_3 \end{aligned}$$

Equality and difference in the mean values of sub-groups was explored by null and alternative hypothesis, respectively.

### 2.3 Econometric Model Specification

Easy estimation and interpretation of results is a major advantage of Cobb-Douglas model (Heady & Dillon, 1961). Later, Beattie & Taylor (1985) introduced the logarithmic transformed form of Cobb-Douglas model because of easy coefficient estimation in linear form as:

$$\ln Y = \ln a + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \beta_9 \ln X_9 + \ln U_i \text{ --- (4)}$$

Where;

Y	=	Average revenue (Rs.)
X <sub>1</sub>	=	Education (Years)
X <sub>2</sub>	=	Contacts with extension agents (No)
X <sub>3</sub>	=	Open field capsicum/bell pepper experience (Years)
X <sub>4</sub>	=	Land preparation cost (Rs.)
X <sub>5</sub>	=	Seed cost (Rs.)
X <sub>6</sub>	=	NPK (Kg)
X <sub>7</sub>	=	Chemical applications Cost (Rs.)
X <sub>8</sub>	=	Irrigation cost (Rs.)
X <sub>9</sub>	=	Labour cost (Rs.)
ln	=	Natural logarithm
a	=	constant
U <sub>i</sub>	=	Error term which shows the effect of unexplained factors
β <sub>1</sub> ..... β <sub>12</sub> , are coefficients of estimates.		

## 3 Results

Table 1 reveals the mean and ANOVA of socio-economic variables. On an average, large farmers had more education (10.50 years), operational land (36.03 acre), contact with extension agents (4.11), open field capsicum production area (1.06 acre) and experience in open field capsicum (6.64 years). Age (41.10 years) and family size (9.52) was more for medium farmers. The difference in mean was insignificant for age, family size and open field capsicum area but it was significant for education, land holding, contacts with extension agents and experience in open field capsicum.

Table 1 Mean and ANOVA of various socio-economic variables.

Particulars	Farm Size Category			ANOVA	
	Small	Medium	Large	F-value	Sig.
Age (years)	39.58	41.10	39.83	0.091	0.913
Education (years)	6.52	8.76	10.50	5.288	0.007
Family Size	8.45	9.52	7.50	1.699	0.191
Total operational holding (acres)	6.41	15.74	36.03	200.288	0.000
Contacts with extension agents	3.19	3.81	4.11	3.529	0.035
Open field capsicum experience (years)	4.68	5.79	6.64	3.096	0.052
Open field capsicum area (acres)	0.95	1.01	1.06	0.587	0.559

Table 2 depicts the average variable cost incurred in per acre production of open field capsicum. On average, expenditures of large farmer were high on seedling transplantation (Rs. 3,717.44) and hoeing (Rs. 4,151.39). On average, medium farmer spend more financial resources on land preparation (Rs. 13,759.54) and irrigation (Rs. 8,127.98). On average, small farmers spend more money on seed (Rs. 7,517.95), fertilization (Rs. 47,118.55), earthing up (Rs. 2,568.13), picking (Rs. 37,613.23), pesticide and weedicide (Rs. 21,363.88) and marketing (Rs. 93,298.88). Total variable cost was more for small farmer (Rs. 237,375.02) followed by medium (Rs. 218,738.53) and large farmer (Rs. 218,450.98). Large farmer paid more land rent (Rs. 24,347.22) while interest on variable cost (Rs. 9,495.00), administrative cost (Rs. 7121.25) and abyana (Rs. 89.68) were higher for small farmer. Total production cost was also higher for small farmer (Rs. 277,064.82).

Table 3 describes that the small farmers get more production (21,209.27 kg acre<sup>-1</sup>) and price (Rs. 25.33 kg<sup>-1</sup>). The difference

in the average price received by different sub group was found insignificant. Total revenue was also more for small farmers (Rs. 537,264.67 acre<sup>-1</sup>). Both GM (Rs. 300,118.06 acre<sup>-1</sup>) and NI (Rs. 262,360.17 acre<sup>-1</sup>) were more for medium farmer. BCR was high for medium farmers (2.02) followed by small (1.94) and large (1.70) farmer. It depicts that medium farmer received Rs. 2.02 in return by investing rupee one in open field capsicum production.

Table 4 explains the acceptability of Cobb-Douglas model for capsicum according to R<sup>2</sup> (0.706), adjusted R<sup>2</sup> (0.662) and f-statistics (16.006). The regression coefficient was significant and positive for education which shows 0.066% increase in revenue for 1% increase in education. The increase in revenue was 0.172% and 0.130% due to 1% increase in experience and labour cost, respectively. The revenue was decreased by 0.213% and 0.094% as a result of 1% increase in land preparation cost and chemical (pesticide) cost respectively.

Table 2 Total production cost acre<sup>-1</sup> (Rs.) in open field capsicum

Production Practices/ Costs	Sub-Groups			Standard Error of Mean
	Small	Medium	Large	
Land Preparation	13040.66	13759.54	13457.03	361.96
Seed	7517.95	7051.81	7387.65	157.14
Seedling Transplantation	3486.06	3349.21	3717.44	173.74
Fertilization	47118.55	37416.67	46436.11	2755.20
Hoeing	3698.32	3376.82	4151.39	248.09
Earthing up	2568.13	1900.42	1952.65	162.18
Pesticide + Weedicide	21363.88	20094.99	18547.99	635.76
Irrigation	7669.35	8127.98	7163.58	303.76
Picking	37613.23	30703.80	31182.05	1623.08
Marketing	93298.88	92957.30	84455.09	2223.17
Total Variable Cost (TVC)	237375.02	218738.53	218450.98	4494.13
Interest on TVC @ 8% (6 months)	9495.00	8749.54	8738.04	179.77
Administrative cost (3% of TVC)	7121.25	6562.16	6553.53	134.82
Land Rent (Six Months)	22983.87	22357.14	24347.22	635.00
Abyana	89.68	89.05	88.33	2.44
<b>Total Cost</b>	<b>277064.82</b>	<b>256496.42</b>	<b>258178.11</b>	<b>4903.97</b>

Table 3 Economic analysis of per acre open field capsicum production.

Indicator/Unit	Sub-Groups			Standard Error of Mean
	Small	Medium	Large	
Production (Kg)	21209.27	20706.31	18953.06	578.03
Average Price (Rs. Kg <sup>-1</sup> )	25.33	25.06	23.19	0.61
Average Cost (Rs. Kg <sup>-1</sup> )	13.06	12.39	13.62	0.40
Total Revenue (Rs.)	537264.67 (5126.82 \$)	518856.59 (4951.16 \$)	439556.34 (4194.44 \$)	17813.08
Gross Margin (Rs.)	299889.65 (2861.68 \$)	300118.06 (2863.86 \$)	221105.35 (2109.88 \$)	17085.37
Net Income (Rs.)	260199.85 (2482.94 \$)	262360.17 (2503.56 \$)	181378.23 (1730.79 \$)	17249.93
<b>BCR</b>	<b>1.94</b>	<b>2.02</b>	<b>1.70</b>	<b>0.07</b>

#### 4 Discussion and Conclusions

Open field capsicum production is a profitable activity and it was in line with the results of Sanusi & Ayinde (2013), Olayiwola (2014) and Daundkar & Bairagi (2015). Per acre cost of chilli production was N 35,264.12 (Rs. 11,763.12) with a BCR score of 1.78 in Nigeria (Olayiwola, 2014) which was close to the findings of current study. Positive education coefficient was in line with previous studies (Ibekwe & Adesope, 2010; Mwangi, 2012; Khan & Ghafar, 2013; Mohammed, 2015). An educated farmer has the ability to understand new technology and learns about better production practices. The increase in revenue due to increase in experience was in line with Ibekwe & Adesope (2010). Chemical cost placed negative impact because many farmers used chemicals to avoid disease attack without consulting an agronomist or entomologist. Positive coefficient of labour cost was in line with Khan & Ghafar (2013), Mari (2009) and Mwangi (2012).

Price instability, high middle man margin, expensive inputs, low quality inputs, lack of extension services and disease attack were the major issue as told by the respondents. Due to

these problems, farmers prefer the cultivation of staple food crops with attractive support price like wheat. Government should improve the services of extension department, to aware the farmers about optimum utilization of resources such as fertilizer, water and pesticides. Government should establish farmer field schools for the training of farmers about modern practices in agriculture. Monitoring teams should check the quality of agricultural inputs in retail market.

#### Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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Table 4 Regression results of Cobb-Douglass production function.

Variables	Unit	Coefficient	t-value	p-value
Constant		14.291*	10.109	0.000
ln-education	Year	0.066***	1.904	0.062
ln-contacts with extension agents	No.	0.270*	4.043	0.000
ln-capsicum growing experience	Year	0.172*	4.504	0.000
ln-land preparation cost	Rs.	-0.213**	-2.329	0.023
ln-seed cost	Rs.	-0.057	-0.564	0.575
ln-NPK	Kg	-0.024	-0.498	0.621
ln-chemical cost	Rs.	-0.094***	-1.791	0.078
ln-irrigation cost	Rs.	0.018	0.374	0.710
ln-labour cost	Rs.	0.130***	1.738	0.087
<b>R<sup>2</sup></b>		<b>0.706</b>		
<b>Adjusted-R<sup>2</sup></b>		<b>0.662</b>		
<b>F-ratio</b>		<b>16.006</b>		

\*significant at 1%, \*\*significant at 5%, \*\*\*significant at 10%

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