

## Research Article



# Impact of Socioeconomic Factors and farm Size on Wheat Productivity: A Case Study of District Peshawar, Pakistan

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**Abstract** | This study investigates the impact of socioeconomic characteristics as well as the farm size of wheat productivity in district Peshawar. Wheat is the main staple food item of the country's population and the largest grain crop as well. Pakistan has been regularly importing wheat, except for the few years. This study is based on primary data collected in 2019 from district Peshawar. A sample of 200 (160 large and 40 small) wheat growers were taken from twelve selected villages of Peshawar. An unpaired t-test was used to test the differences in the socioeconomic factors and farm sizes on the wheat production. Chow test were used for structural differences and dummy variable were introduced in the production function to test any significant productivity differentials (if any) between two farm groups. A significant difference was found owing to the socioeconomic factors of two farm groups. Moreover, the Chow F-Ratio confirmed the differences between small and large farms in terms of yield. The statistical value of dummy variable posted higher productivity for the large farms (almost 14%). Hence, results call for higher attention to be diverted to small farms as majority of land owners in Peshawar. The farmer's have small holdings and lack of adequate access to inputs, agriculture credit and extension services left them technically inefficient. In addition, it is suggested that government and private sector should initiate programs to educate and train the farmers in order to bring advance techniques or improve their conventional agriculture practices to increase wheat productivity.

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## Introduction

Pakistan's agriculture sector plays a central role in the economy as it contributes 18.9 percent to GDP and absorbs 42.3 percent of labour force. It is also an important source of foreign exchange earnings and stimulates growth in other sectors (GoP, 2018).

This sector also fulfils the supply of basic food and fiber needs of the country's growing population and

the economy. Wheat is main staple food item of the country's population and largest grain crop (Ahmad et al., 2002).

The production of food grain in the predominant agriculture economy of Pakistan is considerable. Food grains are important because it account for the major component of food. Increase in production of food crops become more important under the situation where a large proportion of the population lives in

absolute poverty as well as the population growth is continuously high, increasing the demand for food product.

Wheat (*Triticum aestivum* L.), is a leading food grain of Pakistan, covered the largest area. It belongs to family of Poaceae (a major cereal crop), which plays an important role in food and nutritional security. Wheat covers two third (2/3) of the acreage under cereals crops in the world (FAO, 2009) and hence it ranks first in acreage, production and consumption among all food crops. It contributes 8.7% to the value added in agricultural and 1.7% to GDP. In Pakistan, total area under wheat is 8825 thousand hectares, with production of 24,946 thousand tonnes and the productivity of 2,887 kg/ha (GOP, 2018). In Khyber Pakhtunkhwa, area under wheat is 748,650 hectares with production of 1365141 tonnes and the productivity of 1823kg/ha (GoKP, 2017).

Current, the per hectare yield of wheat in Pakistan is very low as compared to some other countries of the world, which also include some less developed countries. These countries are getting substantially higher yields due to several factors as identified in the literature including seed quality, fertilizer, use of herbicides, water availability and technology which all contribute to higher production. According to Mburu *et al.* (2014), farmers schooling years, experience and fertilizer has a strong influence on wheat productivity in large farms as compared to small farms. Similarly, the impact of socioeconomic factors on crop productivity were studied by different researchers (Ali *et al.*, 2020; Hashmi *et al.*, 2015; Bagal *et al.*, 2018; Hassan *et al.*, 2010; Begum *et al.*, 2016). Similarly, different research studies were conducted on comparative analysis of farmer's socioeconomic characteristics in different farm sizes (Aurangzeb *et al.*, 2007; Sial *et al.*, 2012; Shah *et al.*, 2016; Mehmmmod *et al.*, 2014) while few also highlighted the effect of farm size on farm productivity (Bhuiyan, 1987; Khan, 1979; Saqib *et al.*, 2016). The present study is designed with the objective to investigate the difference in farmer's socioeconomic characteristics as well as the difference in their perceived effect on wheat production between small and large farm in district Peshawar, Khyber Pakhtunkhwa.

### Hypotheses of the study

The objective of the study is to test the following hypothesis.

H<sub>1</sub>= There is no significant differences between the

socioeconomic factors of two farm groups.

H<sub>2</sub> = There is no structural differences between the two farm groups.

H<sub>3</sub>= There is no difference in farm productivity between two farm groups.

## Materials and Methods

The present study was conducted in district Peshawar, one of the highly irrigated and fertile wheat-producing district of Khyber Pakhtunkhwa (GoKP, 2008). The district Peshawar is comprised of four towns (tehsils) namely Town-I, Town-II, Town-III, Town-IV. Two towns (Town II and Town IV) were purposively selected on the basis of rural population. A list of wheat growers was obtained from the office of the concerned extension circle of agriculture department Khyber Pakhtunkhwa. Three Union Councils from each town were selected randomly. Lala, Nahqi and Gulbela from town II and Merakachori, Aza khel and Urmar Miana from town IV were selected. Out of six Union Councils, two villages were selected conveniently due to time constraints. A sample of 200 wheat growers from twelve (12) selected villages of the chosen towns was drawn by employing Yamani formula (1967). Data were collected through in-person interview method in the month of September-October 2019. Sampled wheat growers were divided into two categories on the basis of land holding i.e. small farmers-having less or equal to 5.0 acre and large farmers-possessing above 5.0 acre landholding; following Saqib *et al.* (2016). Proportional allocation method of stratified random sampling was used for the distribution of wheat growers among the sample villages as follows.

$$n_i = \frac{N_i}{N} \times n \quad \dots (1)$$

Where;

n<sub>i</sub>: No. of sampled wheat growers in i<sup>th</sup> Village; i: 1, 2, 3, .....12; n: Total No. of sampled wheat growers; N: Total No. of wheat growers in the study area; N<sub>i</sub>: Total Number of Farmer in the Village.

### Specification of the model (Production function)

To find out the impact of socio economic factors on the production of wheat in district Peshawar, the functional form was used in the present study as given below (Bhuiyan, 1987).

$$Q = f(D, Edu, Age, FS, L_w, Fert, K, IP, WP, Exp)$$

The specified econometric model for this study is as follows:

$$\ln Q = \beta_0 + \beta_1 D + \beta_2 \text{Edu} + \beta_3 \text{Age} + \beta_4 \text{FS} + \beta_5 \ln L_w + \beta_6 \ln \text{Fert}_w + \beta_7 \ln K + \beta_8 \text{IP} + \beta_9 \text{WP} + \beta_{10} \text{Exp} + U$$

Where;

Q= Total production of wheat (tones) produced per acre; D= Dummy for farm size (0 for small farm and 1 for large farm); Edu=Education level of the sampled farmers (Schooling years); Age= Farmers age in years; FS= No. of family members/family size;  $L_w$  = Labour in term of man-days spent on wheat farm per acre;  $\text{Fert}_w$  = Amount spent on fertilizer use for wheat crop per acre (In Pakistani rupee); K= Capital amount spent on wheat crop per acre (In Pakistani rupee);  $\text{IP}_w$  = Value if Insecticides and pesticides used per acre (In Pakistani rupee); WP= Price of wheat per maund;  $\beta_i$  = Parameters showing the output elasticities of inputs; U= error term.

**Table 1: Village wise distribution of sampled wheat growers in the study area.**

Towns/ Tehsils	Union coun- cils	Villages	Small farms	Large farms	All farms
Town I	Lala	Tambalpura	10	05	13
		Kala kaley	08	04	11
	Gulbela	Gulbela kaley	12	06	15
		Mashai	15	07	22
	Nahqi	Daman Afghani	11	04	15
		Mian Gujar	10	05	11
Town II	Mera Kachori	jhagra	13	03	16
		Mera Kachori	08	04	08
	Urmarmiana	Umar talab	15	04	19
		Urmarmiana	11	05	13
	Urmarpayan	Urmarpayan	10	04	13
		Mandoori	11	05	11
Total			144	56	200

**Source:** Office of extension circle of district Peshawar, agriculture department, Khyber Pakhtunkhwa.

### Analytical instruments

**Test for differences of means ( $H_1$ ):** To test the differences between two averages of two farm groups, the independent unpaired t-test was used (Aurangzeb et al., 2007) that is:

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{n_1 S_1^2 + n_2 S_2^2}{n_1 + n_2 - 2}}}$$

Where;

$\bar{X}_1$  and  $\bar{X}_2$  are the means of two farm groups and  $S_1^2$  and  $S_2^2$  are sample variances of small and large farms respectively.

**Test for structural differences homogeneity of parameters estimated ( $H_2$ ):** The following chow test were used for the homogeneity of parameters estimated between two farm groups (Gujrati, 1995).

$$F^* = \frac{(RSS_p - RSS_L - RSS_s)/K}{(RSS_L + RSS_s)/(N_1 + N_2 - 2K)}$$

Where;

$RSS_p$  = Residuals Sum of Square (pooled),  $RSS_L$  = Residuals Sum of Square (Large farms),  $RSS_s$  = Residuals Sum of Square (Small farms),  $N_1$  = No. of small farms,  $N_2$  = no. of large farms, K = no. of parameters; If  $F^* > F$  (Tab), its means that the two farm groups are significantly structurally different.

**Test for differences in farm productivity ( $H_3$ ):** A dummy variable (1 for large farms and 0 for small farms) was used in the model for testing the difference in the farm productivity between the small and large farms (Khan, 1979).

If the coefficient of dummy variable is not equal to zero, its means that there is difference in the farm productivity between two farm groups.

### Results and Discussion

The socioeconomic characteristics of sample households by farm size are presented in the form of their means, mean differences and significance by employing unpaired Student t-test for difference of means. Table 2 shows that there was a significant difference in the means of all factors including productivity except age between small and large farms. Data reveals that education level had a direct relationship with farm size. Overall education level of sample respondent was very low as compared to the other province of Pakistan. The result regarding the difference in the mean age depict that there was no significant difference in the two farm groups. The average family size, labor, fertilizer, capital, insecticides and pesticides, wheat price, farmers experience and wheat productivity of the sample households by farm size in the Table 2 depicts that, there was a significance

difference in the means of large and small farm. It was also found that there was a direct (positive) relation among the factors and farm sizes. The results were supported by studies of Saeed and Khan (2007) and Aurangzeb *et al.* (2007).

**Table 2:** Test of equality of means of socioeconomic factors between small and large farms.

Variables	Mean values		Mean dif- ferences	T-ratio
	Large farms	Small farms		
Education	6.48	2.56	3.92	4.541*
Age	47.80	42.93	4.867	6.90 <sup>ns</sup>
Family Size	14.20	10.25	3.95	2.95**
labor	7.50	4.73	2.76	10.93**
Fertilizer	5665	3720	1945	20.25***
Capital	10730	8745	1985	18.19**
Insec/Pesticides	2535.70	1874.30	661.27	14.10**
Wheat Price	2075.50	1819.00	56.50	9.90***
Experience	20.50	12.93	7.57	6.97**
Farm produc- tivity	1260.42	797.51	937.77	1.57***

**Note:** \*, \*\* and \*\*\*: Significant at 10, 5 and 1 % respectively.

To test the impact of socioeconomic factors on productivity level of farm groups, homogeneity of parameters estimated (slopes), difference in the productivity level between small and large farms, the above model was estimated for: (i) for large farm (ii) small farm (iii) pooled data (all farm) (iv) pooled data with a dummy variable, 1 for large farm and 0 small farm (Amaefula *et al.*, 2012).

All the model has high explanatory power and indicates that more than half of the variation in the productivity level is due to the socioeconomic factors included in the model. Education, age, family size, fertilizer and wheat price shows positive and significant impact on wheat productivity of large farms while labor and capital show insignificant but positive relationship with wheat productivity. In case of small farms, education, age and capital shows positive but insignificant impact while family size, labour, fertilizer, insecticides/pesticides and wheat price shows positive and highly significant impact on wheat productivity. Results in the Table 3 revealed that education have more influence on wheat productivity of small farms as compared to large farms. The coefficient of age, family size and capital of large farms have more influence than small farms while opposite in case of labour, fertilizer and wheat price of small farms have

more influence than large farms on wheat productivity. Interestingly farmers experience shows a negative but significant impact on wheat productivity in all cases.

#### Test for homogeneity of parameters or structural differences

To test the equality of parameters of the explanatory variables of two farm groups, Chow test was employed by using Residual sum of square (RSS) for small farm, large farm and pooled data presented in the Table 3. Chow F-Ratio was calculated as under:

$$F^* = \frac{191.934 - (78.34 - 87.56)/9}{(78.34 + 87.56)/(144 + 56 - 18)}$$

$$F^* = 5.715^{**}$$

Comparison of F-calculated and theoretical value F-tabulated with  $V_1 = 9$  and  $V_2 = 182$  degree of freedom at 5% level of significance suggest that difference between parameter estimates of two farm groups was statistically significant. In other words, two farm groups structurally and technologically different. This finding were consistent to the earlier results of Sial *et al.* (2012), Saeed and Khan (2007).

#### Test for equal productivity

In order to test the equal productivity between the two farm groups, Equation 1 was estimated for pooled data with dummy variable. The coefficient of dummy variable differentiates two farm groups in term of productivity. The coefficient of dummy for large farm is 0.1398 and is significant at 1% (Table 3). The positive value indicates that large farms shows more (14%) productivity as compared to small farms. This confirmed the results of Chow test for the structural differences between the two farm groups due to the influence of farm size. Result of hypothesis three was supported by the study of (Bhuiyan, 1987; Khan, 1979).

### Conclusions and Recommendations

From testing the three main hypotheses in the detailed analysis of socioeconomic characteristics between small and large farms, it was concluded that there was a significance difference in the socioeconomic factors affecting wheat productivity between two farm groups. Significant difference was found between the estimated parameters in the production function for both farms. The output elasticities of input on large farms were notably higher relative to elasticities of inputs on small farms. It is concluded from the finding



**Table 3:** Influence of socioeconomic factors on wheat productivity.

Variables	Large farms		Small farms		Pooled		Pooled with dummy	
	$\beta$	t-ratio	$\beta$	t-ratio	$\beta$	t-ratio	$\beta$	t-ratio
Intercept	6.034	1.038	5.9854	2.457	5.8843	1.237	5.7543	1.0234
Education	0.0078	1.457*	0.0098	3.781	0.0076	2.589*	0.0087	1.934**
Age	5.0572	3.684*	3.0913	4.590	5.0295	2.974*	4.8724	2.654*
Family size	15.8014	4.673*	13.6924	6.801**	14.6126	4.001*	15.8967	3.750**
labor	0.2321*	5.032	0.3425	4.691**	0.3091	4.078*	0.3290	3.923*
Fertilizer	0.0987	3.254**	0.1092	3.567**	0.9532	2.673**	0.9349	2.673**
Capital	0.0034	1.450	0.0013	1.581	0.0143	2.492*	0.0024	3.324*
Insec/Pesticides	0.0053	2.788*	0.0089	4.791**	0.0076	3.887*	0.0087	2.345**
Wheat Price	0.2761	1.348*	0.3971	2.903**	0.2619	1.923*	0.2871	1.927**
Experience	-0.0472	-3.712*	-0.2013	2.391*	-0.0071	-3.015*	-.0013	2.972***
Dummy								0.1392**
Residual SS	78.34		87.56		185.78191.934		191.934	
R <sup>2</sup>	0.761		0.693		0.795		0.810	
Adj R <sup>2</sup>	0.732		0.641		0.739		0.789	
F-Ratio	311.23**		281.45**		489.25**		497.34***	

**Note:** \*, \*\* and \*\*\*: Significant at 10, 5 and 1 % respectively.

of Chow test for structural differences that there was a remarkable technological gap between the two farms. Finally, the results of Chow test are confirmed by introducing a Dummy (large farms) variable in the production function for equal productivity between two farm groups. It is concluded from the coefficient of dummy that large farms show almost 14% higher productivity than the small farms.

Results of the current study suggest the following recommendations to minimize the technological and productivity gap between small and large farms.

- Education level of farmers is necessary to improve productivity. Therefore, government and agencies should initiate programs to educate small farmers and improve traditional agriculture.
- Large farms are better placed than small farms with respects to input use. Therefore, small farms should be given adequate access to these inputs so that they may be at least equally technically efficient.
- Farmers must be trained by extension programs in order to use the inputs efficiently.

## Novelty Statement

This research provides sufficient information about the farmer's socioeconomic characteristics differences and its impact on wheat productivity of the study area.

## Author's Contribution

**Sajad Ali:** Principal author, who conducted research, experiments and wrote first draft of the manuscript.

**Naeem Ur Rehman Khatak:** Supervised the research study.

**Iftikhar Ahmad:** Helped in data analysis and interpretation.

**Jangraiz Khan:** Provided in technical guidance at every step.

**Azra:** Helped in overall format of the manuscript.

## Conflict of interest

The authors have declared no conflict of interest.

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