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The Role of Farmers' Education in Bolstering Cereal Yields: A Case Study of Cereals in Punjab

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ABSTRACT

Pakistan is an Asian developing country, with the agriculture sector being the largest in terms of labor participation. Agriculture has a positively significant effect on the total GDP of Pakistan. This study emphasized the role of education in increasing the productivity of cereal-producing farmers of Punjab. The data was taken from the Pakistan Economic Research Institute (PERI), as the survey of this institute is reliable. Relevant data was extracted from the questionnaire and thus, the regression analysis was done. Agriculture highly contributes to Pakistan's GDP and serves as the backbone of our country. According to the results, it is concluded that education increases the productivity of farmers by enhancing their skills and decision-making ability. Thus, better education facilities should be provided to the farmers in rural areas so that the country can benefit from increased output.

1 Introduction

Pakistan is an Asian developing country, with the agriculture sector being the largest in terms of labour participation. Agriculture has a positively significant effect on the total GDP of Pakistan (Rehman et al., 2015). It acts as a backbone for the economy of Pakistan, as it contributes 21% of the annual GDP, provides employment opportunities to 44% of the labour force and major products like cotton, wheat and rice are exported to various countries bringing about 65% of the total earning (Azam & Shafique, 2017). It is necessary to improve the utilization of fertile land and other resources available to the farmers. Training programs need to be introduced by the government of Pakistan for the well-being of farmers and to educate them about the use of pesticides and other chemicals (Khan, Mahmood, & Damalas, 2015), (Mahmood, Kächele, & Kong, 2021), Liu et. al., (2022). All over the world, cereal is being produced by the agriculture sector, to fulfill the rising demand for food. Output must be increased to maintain a balance between the food supply and demand of the increasing population of our country.

According to the Agriculture Statistics of Pakistan, Punjab has a major contribution to the agriculture of the country, as it provides 80% of the total cotton, 78% of wheat, 43% of maize 90% of fine aromatic and 60% of sugarcane. The total cultivated area of Pakistan is 21.04 million hectares, out of which 11.31 million hectares is occupied by Punjab. Since Punjab has the most irrigated land in Pakistan and our population relies heavily on cereals to meet their daily nutritional needs, Punjab is where cereals are mostly cultivated. During the autumnal Rabi and springtime Kharif cropping seasons, farmers

primarily plant wheat and rice, respectively (Agriculture, 2022). Arable land and water are Pakistan's main natural resources. Of Pakistan's total area of 796,095 (km^2), 22 million are under cultivation, and the remaining 8.3 million are uncultivated. According to Kamal et. al., (2022), rice is produced on 2.4 million hectares while wheat covers 8.5 million hectares. These two crops account for 70% and 18% of the world's total food grain production, respectively. To produce crops, demand for fertile land also increases for better quality and quantity of crops. To enhance the utilization of available land, technology, and other inputs, it is necessary to educate farmers. Farmers should be given information regarding the use of innovations and pesticides to increase the output by using the same input. They should be trained and educated to deal with the changing climate and utilization of extension services. In this way, the issue of food security can be dealt with. Education, farm experience, and extension services provided to the farmers can play a significant role in enhancing the output (Wouterse & Badiane, 2019). Thus, the study focuses on the provision of education in rural areas and the production of farmers in Punjab. The study will explore the production of educated and uneducated farmers and the differences in their output.

Scholarly interest in the relationship between farmers' education and agricultural yields has been considerable, especially when it comes to Punjabi cereal farming. Higher education levels among farmers are positively correlated with increased productivity, according to studies by academics like Ataei et al. (2021) and Sedebo and Li (2022). This relationship is explained by the acquisition of knowledge and skills necessary for the adoption of cutting-edge farming technologies. Okeyo et al.'s research findings from 2020 further clarify that farmers with higher levels of education are more likely to make knowledgeable decisions regarding crop management, incorporating techniques like precision farming and optimal irrigation—practices that greatly increase yields. Ismail (2023) draws attention to the complexity of this relationship by highlighting the mediating roles of market knowledge, extension services, and resource access. Furthermore, Hu and Wang (2022) examine how socioeconomic factors—like the size of landholding and income levels—may interact with education to affect how learned skills are applied in real-world situations. Building on the insights offered by these influential works, the proposed study aims to add to the body of knowledge by performing a case-specific analysis to clarify the distinct dynamics of how farmers' education affects cereal yields in Punjab.

2 Significance of the Study

The study examines the relationship between education and total output of farmers and therefore it will be helpful to propose a minimum level of education required for the farmers to enhance their total output of cereals. This study contributes by proposing a method to increase the output of farmers and hence increase their income earned by this output. Educated farmers can make better decisions regarding their inputs to be utilized in the best way and output to be sold in markets at good rates. This study aims to examine the relationship between the education of farmers and their total output of cereals and to find out how education can be utilized to improve the total output in Punjab, Pakistan.

3 Research Gap

This study will determine the effect of education on the total output of cereals production in Punjab. For this purpose, primary data was taken by PERI (Punjab Economic Research Institute). After this extensive review of international and domestic literature, it is found that no such study has been conducted in which the impact of education is explored on cereal production in Punjab. According to the study, lack of education and information hurt the output, as the farmers were not aware of new technology, and its uses and could not allocate their inputs and land properly.

4 Objectives of the Study

The objectives of the study are as follows:

- To examine the relationship between education and productivity of cereals in Punjab.
- To examine the extent to which education can affect output produced by farmers.

5 Empirical Model

Independent variables were the number of labourers working on the farm, capital utilized (expenditure on purchased tractors and tube wells), land cultivated (in acres), the value of purchased inputs (fertilizers, pesticides, seeds), and education years. The equation to be estimated in this study is shown below;

$lnY_i = \alpha_0 + \alpha 1 lnL_i + \alpha 2 lnK_i + \alpha 3 lnA_i + \alpha 4 lnP_i + \alpha 5 lnE_i + e_i \ldots \ldots (1)$

Where,

Y= Value of output (average income generated)

α_0= Intercept (the value of Y when all other independent variables are 0)

L= Labor (number of adults permanently working on the farm)

K= Capital (expenditure on purchased equipment)

A= Land size cultivated

P= Expenditure on purchased inputs

E= Number of years of schooling

e= Error term

α (0, 1, 2, 3, 4, 5, 6) represents the coefficients of the various independent variables.

6 Methodology

OLS technique was used to get the results and relationship between education and its impact on the total output of farmers. To determine the effects of education on the total output of farmers, the Cobb-Douglas Production function adapted from Lockheed et al, (1980) was used with the output being the dependent variable. Ordinary Least Squares (OLS) estimation with the Cobb-Douglas production function is important when examining how farmer education affects agricultural yields for several reasons. OLS is a popular statistical technique that reduces the sum of squared differences between observed and predicted values to help quantify the relationship between variables. In this instance, OLS makes it possible to estimate the parameters in the Cobb-Douglas production function, which aids in determining how farmer education affects Punjab's cereal yields. It offers a strong framework for evaluating the statistical significance of educational attainment in affecting agricultural productivity, assisting researchers and policymakers in reaching well-informed conclusions to improve agricultural results.

7 Data and Variables

Punjab has a major contribution to the agriculture of the country as compared to the other provinces. According to the statistics, Punjab contributes 83% of the total cotton, 80% of wheat, 51% of maize, 97% of fine aromatic and 63% of sugarcane produced in Pakistan, which shows that agriculture production in Pakistan is highly contributed by Punjab. The statistics also show that the total cultivated area of Pakistan is 22.04 million hectares, out of which 12.51 million hectares are occupied and cultivated in Punjab which is about 56.76% of the total area cultivated. According to the same source, it is revealed that the total number of villages in Punjab is 27059 and the number of farming families is 3864070 (3.864 million), whereas several farming families having less than 12.5 acres of land is 3667712 (3.67million). Keeping in view the other details, data for the year 2017-18 is taken from the Punjab Economic Research Institute (PERI), which was collected with the help of a questionnaire and farmers were asked about their inputs, production, capital, land, education, family size etc. The

questionnaire was filled out by the interviewers based on the answers provided by the farmers. The data collected was coded and examined on E-Views and Microsoft Excel.

The data was collected by filling out the questionnaire after interviewing the farmers. It was necessary to get their interviews done, as most of the farmers were uneducated or less educated and were not able to fill out the questionnaire by themselves. The questionnaire included the details of their family size, area, land, inputs, capital, crops produced by them etc. Farmers were unable to quantify their income, thus the value of output produced was used to estimate their income generated and during estimation, it is considered as a dependent variable. Independent variables include the land size that is cultivated by the farmers, capital utilized by them such as tractors and tube wells, number of the labour force working on the land, other inputs such as fertilizers and seeds used during cultivation and education years acquired by the household head. These variables altogether affect the output produced by the respondents and all this information was gathered through the interviewers. The respondents were interviewed, and a questionnaire was filled out according to the answers given by them. For this research, only cereal-producing farmers were shortlisted out of the whole population of Punjab, and their data was observed. Number of cereals-producing respondents was 829, out of which majority were uneducated or less educated. Data of cereal-producing farmers will be utilized in the research and their output value will be observed to determine the effect of education by comparing the output of educated and uneducated farmers.

8 Graphical Analysis

The sample taken for the study consists of 829 cereal-producing farmers, out of which some grow only one crop, and others grow more than one crop at a time, depending upon the land size they own. Starting from the least produced cereal i.e., maize, the count shows that only 6% of the cereal-producing farmers of our sample, grow maize and it is grown by only 50 farmers. Maize is not only grown in Punjab but also in KPK. According to the statistics, 97% of the total maize produced in Pakistan comes from these two provinces and many farmers growing maize also grow wheat at the same time.

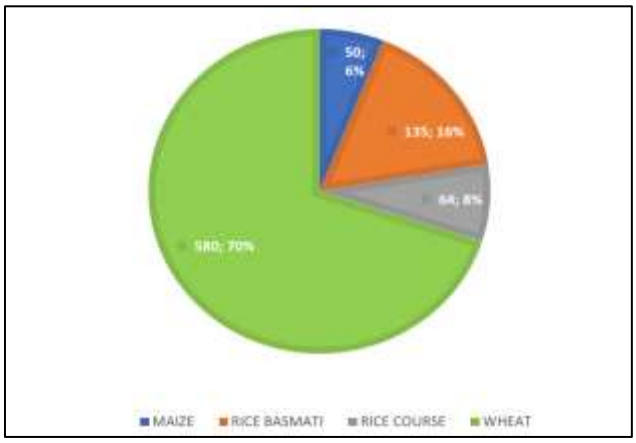

Figure 1

Count of Crops Cultivated

The X-axis represents the years of education, while the y-axis represents the number of farmers who have attained that education. Getting a higher level of education is not common in rural areas of our country, as people living there are deprived of basic facilities including education. They start gaining basic education from nearby schools, as the data of our sample shows that the maximum number of farmers have attended school for only 2 years of education I.e., 257 farmers out of 829. Farmers who have attended school for 5 years are 170, after which they did not go to school for further education.

Figure 2

Count of Educated Farmers

9 Results and Discussion

This study emphasized the role of education in increasing the productivity of cereal-producing farmers of Punjab. The data was taken from the Pakistan Economic Research Institute (PERI), as the survey of this institute is reliable. Relevant data was extracted from the questionnaire and thus, the regression analysis was done. Agriculture highly contributes to Pakistan's GDP and serves as the backbone of our country.

Table 1

Outcome of Regression Analysis

Variable	Coefficient	S.E	t-stat	P-value
Constant	2.988	0.0915	32.648	0.000
Labour	0.002	0.0018	1.1724	0.241
Capital	0.016	0.0007	22.158	0.000
Land Size	0.141	0.0039	35.833	0.000
Input	0.940	0.0603	15.569	0.000
Education	0.067	0.0004	141.07	0.000
R^2	0.982		Prob(F-statistic)	0.000

Source: Author's calculation

Table 1, shows the results of the regression analysis for the determinants of agriculture production in Punjab, Pakistan. Following the above results, the probability of C is significant indicating that, while keeping other variables constant, the output is significantly increasing and future researchers can investigate the agriculture productivity by adding some other factors to the model. The effect of each independent variable is separately discussed below, keeping in view their coefficient and significance. According to the results, the value of the coefficient for labour is 0.002 and its probability is 0.241, showing that by keeping other variables constant, labour can bring a 0.2% change in the output. The sign is positive, and its probability is insignificant, which shows that there is a positive and insignificant association between labour and agriculture productivity according to this study.

Technical efficiency is the farmer's capability to make better choices in terms of input and make better economically rational decisions Pudasaini, (1983).

The second variable of the model is Capital, that is used by the farmers for the irrigation purposes. It includes the value of tractors and tube wells utilized by the farmers for their farming. According to the results, the coefficient is positive and significant, meaning that capital would lead to a 1.6% change in the output. Thus, we can say that capital utilization by the farmers enhances their output at a high level. It is stated that there is a positive and significant relationship between capital and farm productivity in Punjab, Pakistan. The results are fully supported by previous researchers from different countries. A study revealed a significantly positive relationship between capital allocation and farm productivity in the study conducted in Offinso municipality Oduro-Ofori et al., (2014). Similarly, another research also resulted in indicating a positive effect of the utilization of innovations, inputs and technical efficiency of farmers on the output produced by them Geta et al., (2013). The coefficient of land size being 0.141, shows that a unit change in land size changes the agriculture productivity by about 14% in Punjab, Pakistan. The variable of land size is affecting the output by a large percentage; the reason behind this increase is that the unit land increased is also considered to be cultivated. Hence, as the cultivation area increases, it eventually results in more output for the farmers. A study emphasized some factors including land size that have a positive and significant relationship with the output production of farmers Saqib et al., (2018). Input, including materials used in agriculture other than capital, such as seeds purchased, their sowing and ploughing, bund making, chemical fertilizers, pesticide sprays, weedicides sprays, payment of threshing etc. Input shows that there is a positive and significant relationship between the log input and agriculture output in Punjab. An increase of one unit in inputs changes the agriculture productivity by about 94% in Punjab, Pakistan. This effect may be caused due to the good quality of seeds and fertilizers purchased by the farmers. It may also be due to sprays used to protect the crops. Hence, we can say that the farmers choose the best of every input to increase the output quality and quantity. According to research having similar results, timely availability of inputs can play a major role in agricultural output Ahmad et al., (2018). According to similar results of another research, the efficiency of farmers is affected by the level of attention given by them to the farm and access to the inputs they use. Access to better inputs increases their efficiency significantly Coelli et al., (2002). For the most critical factor in this study i.e., Education, the sign of the coefficient is positive with a value being 0.067 and its probability is highly significant. An increase of one unit in education brings a change in agriculture productivity by about 6.7% in Punjab, Pakistan. The results are fully supported by previous researchers from different markets. When the World Bank conducted a survey in 1992 to assess the link between farmers' educational attainment and agricultural productivity in low-income nations, it discovered that farmers with only a basic education were 8.7% more productive than farmers with no education. (2000) Gasperini. The World Bank backs up the idea that there is a correlation between farmers' educational attainment and overall productivity. According to a study on the impact of education on agriculture carried out in Nepal, education increases agricultural output first by strengthening farmers' capacity for making decisions and, secondarily, by reducing their technical inefficiencies. Nepal & Adhikari (2016).

Thus, the variation in the independent variables affects the dependent variables by 98%. Furthermore, the adjusted R-square is 0.982 which is less than the R-square. It is often less than the R-square but shows the real effect of variables and does not change with insignificant variables added or omitted. However, the probability of F-statistics is significant at 0.000. The results also included the mean value for dependent variables like agriculture production i.e., 4.962 which is less than 0.10 or near its central tendency. The table shows the standard deviation of the dependent factor, agriculture productivity is 0.244 which shows the risk in the factor. The value indicates that there is normal risk in the factor.

*9.1 **Heteroscedasticity***

The heteroskedasticity test is a residual test used to check whether the variance of the error terms is distributed normally or not. If the variance varies widely, it means that the problem of heteroskedasticity exists. The results of the heteroskedasticity Test: Breusch-Pagan- Godfrey are presented below. According to the test, if the value of Prob. Chi-Square (5) against Obs*R-squared comes out to be less than 0.05 to 5%, then the problem of heteroskedasticity exists in the model. If the value is more than 0.05 or 5%, it indicates that the results are homoscedastic and the problem of heteroskedasticity does not exist in the model.

Table 2

Heteroskedasticity Test (Breusch-Pagan-Godfrey)

F-statistic	**0.237**	**Prob. F (5,391)**	**0.945**
Obs*R-squared	1.202	Prob. Chi-Square (5)	0.944
Scaled explained SS	20.65	Prob. Chi-Square (5)	0.000

Note: Author's calculations.

In the above results, the highlighted value is to be observed. As the probability is 0.944, which is greater than 0.05 or 5%, we accept the null hypothesis. The model is significant and the problem of heteroskedasticity does not exist.

10 Conclusion & Policy Implications

This study examined the relationship between the education of farmers and the value of the total output of cereals produced by them. It focused on finding out how education can be utilized to improve the total output of cereals in Punjab. Data for the year 2017-18 is taken from the Punjab Economic Research Institute (PERI), which was collected with the help of a questionnaire. The findings of this study show that a positive and significant relationship exists between the independent variables and dependent variables included in the model except labour being insignificant. According to the results of this study, labour has an insignificant relationship with the agriculture output of farmers, whereas all other variables show a positive and significant relationship with the dependent variable. According to the results, it is concluded that education increases the productivity of farmers by enhancing their skills and decision-making ability. Thus, better education facilities should be provided to the farmers in rural areas so that the country can benefit from increased output. Referring towards the first research question of Chapter 1, the study concludes that education has a positively significant impact on the productivity of cereals-producing farmers in Punjab. As the second question is concerned, the results imply that farmers can increase their agriculture productivity by 6.7% if they are provided with the facility of education. Thus, we reject the null hypothesis of both research questions and conclude that education is useful for the agriculture sector, and we can gain benefit from it.

The study contributes to increasing the output of farmers and hence increasing their income earned by this output. The results of the study can be applied in real life by providing farmers with the facility of education, with the help of which they will improve their skills. Betterment in the power of decision-making will result in enhancing their output and they would be able to handle different climatic situations as well. The externality effect will help the neighbouring farmers to improve their output. The positive relationship between education and output shown by the results of the study indicates that the GDP can be improved by improving agricultural output, as agriculture plays an important role in Pakistan's GDP. Thus, local demand for food and exports of our country can be increased significantly.

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