



## Research Article

# Economic Analysis of Fertilizer use and its Price Variability Effects on Wheat Productivity in Punjab- A Case Study of Faisalabad

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**Abstract** | Pakistan is mainstay of its economic development and known as an agricultural country. In the agriculture sector, wheat is the most important crop cultivated in the largest areas in almost every part of the country. In wheat production, fertilizer is one of the important inputs like other crops. In the current growing season, the shortage of fertilizer on the one hand and the higher prices, on the other hand negatively effecting the use of this input in wheat production. This study was designed to identify the impact of fertilizer shortage and their high prices effect on fertilizer use and their subsequent impact on wheat productivity. This study was carried out in the Faisalabad district. Data were collected from 110 farmers in the district of Faisalabad. For data analysis, statistical packages for social sciences and Microsoft Excel were used. The results of the wheat productivity analysis show that the wheat yield was 36 percent lower among sampled farmers. Profitability analysis reveals that fertilizer cost are the highest among the other production costs, accounting for 33.90 percent of the total cost. The value of the benefit-cost ratio is 1.17 in 2022 and 1.42 in 2021 which shows that the net return of the farmers is 25 percent greater than their cost in 2021 and decreases in 2022. The result of study demonstrated that increasing fertilizer prices led to decrease wheat yield. Random-effect regression shows that all the independent variables have a significant effect on wheat yield 2022 as compared to the recent year. The value of R<sup>2</sup> shows variation in the model due to the independent variables. The main increase was observed in DAP, urea, NPK, pesticide cost and quantities. It is suggested that there is a need to lower the fertilizer prices, timely availability of fertilizer, pesticide, and seed. The reason for the decline in wheat productivity was mainly attributed to less use of fertilizer due to soaring prices. Consolidated efforts could be used to improve the market price of wheat by lowering the prices of fertilizer.

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## Introduction

Agriculture is the most important sector of Pakistan's economy and is regarded as the cornerstone of any economy. The least developing countries (LDC) like Pakistan rely heavily on agriculture. This sector has a significant contribution to Pakistan's growth and is also the primary source of the country's economic development. The importance of the agriculture sector cannot be overstated in the present and the future. Its significance would grow exponentially in the light of the growing demand for food security, population, raw material, masses healthcare (Azam and Shafique, 2017).

Agriculture is the largest sector and the backbone of Pakistan's economy providing food to more than 21.2 million peoples, which was considerably higher than the previous years. Performance during the fall of 2021-22 and 2023-2024 is generally positive with a target of 2.8 percent and 6.25%. During this period, major crops grew by 0.34 percent and 16.82%. The country's wheat production performance, with wheat yield increased by 6.6 percent and production reached at 31.4 million tonnes in 2023-2024, and a growth of 11.6% was observed. In Pakistan the most important crops are rice, wheat cotton, and sugarcane accounting for more than 75 percent of total agricultural output value. The crop sectors grew by 11.03 percent, accounting for 6.25 percent of agricultural share and 6.78 percent of gross domestic product. Other crops account for 0.90 percent of agricultural value addition and 2.24 percent of GDP increased by 1.41 percent due to the increased fruits and vegetables production. Agriculture potential in the country is well known, and this sector contributes significantly to crop yield. (GOP, 2023), (GOP, 2024). Wheat is one of the major domesticated agricultural crops. It has been the primary staple diet of Asia, Africa, and Europe for over 800 years. Wheat accounts for roughly one-sixth of all arable land on the planet (PARC, 2013). Pakistan stands at 9<sup>th</sup> place in 2019 and at 7<sup>th</sup> place in 2024 among the wheat-producing countries in the world. In terms of wheat harvest area, it ranked 8<sup>th</sup> position among the top ten wheat-producing countries. Pakistan is the 64<sup>th</sup> largest producer in terms of yield and the 7<sup>th</sup> largest producer of wheat in terms of production as well as in wheat production per person at 44<sup>th</sup> place (FAO, 2019, Data wrapper, 2024). In Punjab, During the 2023-24 the average yield was recorded at roughly 17.2 million acres and cultivated on over 17.4

million acre across Punjab (Asif, 2024). Wheat output stood at 28.18 million tonnes in 2022-2023 and around 29.69 million tonnes in 2023-24 (GOP, 2024). This was achieved due to the technological development in varieties, fertilizer use, and water resource availability. Fertilizer use is an integrated part of the crop production system. Different types of fertilizers like nitrogen, potash, urea, DAP, and phosphorous are used in wheat grain production. It is a well-recognized fact that fertilizers are essential to produce crops to cater to the increasing population needs in Pakistan. In our country, the productivity difference between progressive and resource-poor farmers remains large. Due to the lack of resources, poor farmers cannot use proper fertilizer, quality seed, and other inputs to their potential for crop production. This would necessitate the timely delivery of production technology and inputs at the local and state level, as well as the establishment of fair output prices (Sharif et al., 2020).

### *Fertilizer consumption and prices in Pakistan*

Chemical fertilizer consumption has increased dramatically in the country, particularly in recent years. Yet fertilizer use per acre remains low. Total fertilizer off-take in Pakistan increased 14 fold between 1970 and 2014 (Ali, 2015). In various crop cultivation, balanced and quality use of an expensive input like pesticide, fertilizer, and seed increased the output by 30 to 50 percent. According to the NDFC report, balanced fertilizer application can boost wheat production by 70 percent (NDFC, 1999).

Fertilizer consumption has increased threefold during past thirty years. During 2019-20, Punjab consumed slightly more than two-third of all fertilizers used in Pakistan. The overall production of fertilizer during the fiscal year 2024 is increased by 17.3% to 3.25 million tonnes (GOP, 2024).

In 2024, the global fertilizer usage was 195.4 million tonnes (FAO, 2024). Between the summer of 2022 and at the end of 2023, fertilizer prices nearly doubled. Fertilizer average retail prices are too high for farmers, especially for those growing fertilizer-intensive crops like wheat. The latest fertilizer prices in Pakistan are as follows: Urea Rs. 4046, DAP Rs. 10,000 to Rs. 12047, SOP Rs. 12,170, Sarsabaz NP Rs. 7217; as well as SSP was available at Rs. 2500 to 2750, and CAN Rs. 3511. Hence, the overall crop production percentage is declining due to higher

prices of fertilizer input. Wheat yield was also affected by the change in fertilizer cost. Fertilizer usage affected yield by 52 to 72 percent. That's why farmers avoid prescribed doses (GOP, 2024). Fertilizer prices play another role in increasing wheat prices and low productivity at the global level. Prices of fertilizer are increasing day by day due to these raising issues. As a result, input expenses are also increasing that's why farmers cannot afford inputs at higher prices (Ahmad and Farooq, 2010).

#### *Economics of Fertilizer Use*

Fertilizer use today is sophisticated in the agricultural system and typically approaches an optimum level. Fertilizer use efficiency has improved significantly in industrialized countries. However, its use in underdeveloped countries is frequently inefficient. Wheat, rice, sugarcane, and cotton receive most of the fertilizer. In these crops, the nitrogen application rate was close to 40 percent or less in the case of phosphorous depending on the crop (FAO, 2006).

A steep increase in rates has limited the farmer's purchasing power, which is directly harming the wheat sowing and cultivation in the country (Hanif, 2022). On the other hand, artificial scarcity of fertilizer in the country may have a great impact on crop productivity. According to the ministry of production and industries, 440,000 thousand bags of urea are delivered every day. They further said that 44 lakh bags of fertilizer will be accessible in February 2022 and 82,000,00 bags will be available in March 2022.

Also, farmers say that during wheat sowing at least one bag of DAP per bag is necessary for crop growth. Farmers are concerned that if the current situation continues wheat production target will not be met. This may cause a drop in crop production of 5 to 10 percent, posing major food security challenges to Pakistan's economy (Ahmad *et al.*, 2022). The findings of the study when completed would be very beneficial for the farmers, especially for wheat growers and other farmers who specialized in other crops. This would help farmers to adopt fertilizer at fair prices for the enhancement of the wheat area, production, and yield in the cropping period. It is hoped that this would be the best assistance for researchers to improve the awareness of fertilizer use for wheat and other crops among different farmers of district Faisalabad.

## **Materials and Methods**

This study was organized into sections for compact-

ness and clarity in appearance; the first section focuses on an empirical framework or sampling design to identify and pick the villages, and description of the study area. The second section describes the data gathering and analytical techniques employed in the research. The third section on the other hand focuses on the statistical procedure utilized to achieve the end goals.

#### *Empirical Frameworks*

This section explains the techniques and criteria for selecting the study region which included district, villages, farmers, and study duration.

#### *Selection of Area/villages*

To determine the empirical production function, detailed qualitative information regarding farm output and input is important. To collect this information this study is performed in various areas of Faisalabad district, Punjab province organized during the fall of 2022. Formula was used to pick the adequate number of sample farmers from 10 villages. To achieve the sample size, the required sample size at 95% confidence interval with a degree of freedom of 5% and level of precision of 10% is recommended.

$$N = Z^2 P(100 - P) / x^2$$

Where;

N= sample size.

Z=confidence interval.

P= proportion.

X=accuracy or precision level.

Using the above formula a total of 110 farmers samples were selected from Faisalabad (Mahamud, 2016). A list of all the villages falling under the study area was randomly selected. From each village, 11 farmers were randomly selected to collect the information. A separate list of farmers of the selected 10 villages was prepared along with their socio-economic characteristics. While selecting the farmers from each village it was confirmed that the respondents belong to all the villages.

*Period of Study:* This study was conducted from 2021 to 2022 in district Faisalabad. The study was started from mid of January and continues until Jun 2022. In this fall of the Rabi season harvesting of wheat was ended and most of the farmers start preparing their fields for the next crop. Primary data were collected

through the survey method with the help of pre-tested and pre-structured scheduled from respondents during interaction (Gujrati, 2008). A detailed questionnaire was created for quantitative data collection and personal interviews were scheduled with farmers to obtain the needed information.

*Final questionnaire Development*

The following aspects covered in the Final questionnaire:

- Personal information of farmers like age, education, district, village, farm size, income source, general information regarding land preparation, fertilizer use, quality status, prices, and other farm characteristics were followed.
- Production and profitability analysis of wheat farmers for an economically feasible approach

*Analytical Framework*

*Statistical Technique for Data Analysis:* Descriptive statistics were used to analyze the fertilizer use and its price variability effect on wheat productivity. In descriptive statics maximum, standard deviation, frequencies, mean, percentages, and graphs in the process of describing and examining the demographic output were applied for economic analysis. The cost of production and the profitability analysis is calculated by using the following procedure and formulas. To maximize the profitability, the best management and precise assessment for the cost of production analysis were applied. It was calculated as

Total cost

$$TC = TVC + TFC$$

Whereas,

Variable cost is seed cost, fertilizer, pesticide cost, irrigation cost, raw material, while fixed cost are family labor, maintenance charges, land rent

*Net profit of Wheat*

Profit (II) = Total Revenue (TR) – Total cost of production (TC)

$$\Pi = TR - TC$$

*Benefit-cost Ratio*

The benefit-cost ratio formula is used for estimation of profit of wheat during 2021 and 2022. BCR measured the rate at which the investment of one rupee gives returns in benefit of added rupees. Benefit-cost ratio is measured using formula,

$$BCR = TR/TC$$

*Regression Analysis*

To identify the impact of fertilizer, use and prices on wheat production, panel regression model is used. Random effect Regression is used for analysis of the study between two time periods. The following equation shows the Random effect GLS model.

$$Y_{it} = \beta_0 + \beta_1 X1_{it} + \beta_2 X2_{it} + \beta_3 X3_{it} + \dots + \alpha_1 DtX1_{it} + \alpha_2 D_t X2_{it} + \alpha_3 D_t X3_{it} + \alpha_4 D_t X7_{it} + \alpha_5 D_t X8_{it} + \alpha_6 D_t X9_{it} + \alpha_7 D_t X10_{it}$$

Where,

Y<sub>i</sub> = Yield measured in mounds of <sup>i<sup>th</sup></sup> farmer; D<sub>t</sub>X1<sub>it</sub> = Age of an <sup>i<sup>th</sup></sup> farmer; D<sub>t</sub>X2<sub>it</sub> = Education of an <sup>i<sup>th</sup></sup> farmer; D<sub>t</sub>X3<sub>it</sub> = Wheat farming experience of an <sup>i<sup>th</sup></sup> farmer; D<sub>t</sub>X4<sub>it</sub> = Seed quantity measured per acre <sup>i<sup>th</sup></sup> farmer; D<sub>t</sub>X5<sub>it</sub> = Urea fertilizer quantity measured per acre of <sup>i<sup>th</sup></sup> farmers; D<sub>t</sub>X6<sub>it</sub> = Ammonium Nitrate fertilizer quantity measured per acre of <sup>i<sup>th</sup></sup> farmers; D<sub>t</sub>X7<sub>it</sub> = DAP fertilizer quantity measured per acre of <sup>i<sup>th</sup></sup> farmers; D<sub>t</sub>X8<sub>it</sub> = NPK quantity measured in Rupees of <sup>i<sup>th</sup></sup> farmers; D<sub>t</sub>X9<sub>it</sub> = Pesticide quantity measured per acre <sup>i<sup>th</sup></sup> farmer; D<sub>t</sub>X10<sub>it</sub> = Market price in mounds of wheat <sup>i<sup>th</sup></sup> farmers.

Dummy variable representing 2020-21 time D=1, otherwise D1=0 for 2021-22 time

To test the significance of regression. The standard error and variance of the parameters is calculated in statistical criteria as t, “z” of “f” values, and the goodness of fit of the model based on R<sup>2</sup>. Formula R<sup>2</sup> = ESS/TSS is used to check the goodness/fitness of the model.

**Results and Discussion**

Analysis regarding the socioeconomic characteristics like age of the respondents shows that a maximum of 60 farmers were found more than 45 years old. Similarly, results regarding the education level of farmers exhibit that the maximum educational level frequency was 54 under metric category in the study area. It was also observed that farmers were earning an average off-farm income of 265596.16, average income earn from farming was 325568.81, while the total income from both sources was 452275.23 annually. The average distance of the farm from the main road was 6.27 kilometers with 7.63 kilometers towards the main market for sealing their products. A maximum number of farmers have their own income source, and they were earning an average income of Rs. 325568.81 annually.

**Table 1:** Fertilizer costs analysis.

Fertilizer Bags		Urea	DAP	NP	AN	NPK	SSP	FYM
Ave. unit/acre	2020-21	1.57	1.06	1.28	1.5	1	2.33	1.67
Average Cost/acre		1940.78	4695.83	2868.75	1600	2950	1133.33	1800
Minimum cost		1700	1000	2600	1600	1600	850	1700
Maximum cost		3600	8600	3500	1600	1600	1400	2500
Total cost		13838.69						
Ave. unit/acre	2021-22	1.53	1.00	1.17	1.5	1	2.5	2.4
Average/50 kg bag rate Rs.		1930	10,000	6300	1570	2950	2000	2420
Average Cost/acre		3766	8609.94	716.45	1600	2400	1725	5808
Minimum cost		1600	4000	2950	2100	2400	1050	2000
Maximum cost		32200	10,000	6800	2500	2400	2400	3000
Total cost		24625.39						

*Cost of Production Analysis*

During the study year (2022), Profitability analysis shows that fertilizer cost was Rs. 23184.48, is the highest cost among other production costs which constitutes 33.90% of the total cost. Likewise, land preparation, irrigation, harvesting, and threshing costs are high constituting 10.67%, 9.02%, 6.33% and 7.17% respectively. Fertilizer cost, harvesting cost, threshing cost and land rent accounts for about 78.36% of the total cost of production per acre. Similarly, irrigation, pesticide, plant protection cost was found to be Rs. 6179.895, Rs. 3584.731, and Rs. 3584.48 accounts for 20% of the total cost. Land preparation cost and seed and sowing cost contribute the remaining 16.39% to the total cost of production per acre. The total cost of production per acre was Rs. 68367.67 with land rent and Rs. 53367.67 without land rent. The average wheat grain yield is 36.64 mounds per acre and farmers receive Rs. 2200 as sale price per 40 kilogram. The sold wheat grain provides Rs. 80608 returns to the farmers. The gross margin is Rs. 68367.67 per acre. Profitability analysis shows the net returns after subtracting the cost of production Rs. 12240.33 per acre.

*Fertilizer cost per acre analysis:* Every farmer has their own farm characteristics. Information on total fertilizer costs for the production years 2020-21 and 2021-2022 is presented in (Table 1) The total fertilizer cost was found Rs. 13838.69 units per acre for the year 2021-22 include the same items of the previous year. The minimum and maximum values of the total fertilizer cost in 2020-21 was higher as compared to 2021-22 time fall. The total fertilizer cost was found Rs. 19932.22 units per acre for the year 2021-22 include the same items of the previous year. It was

clearly observed that the fertilizer cost is increased in the current year.

*Total Cost of production:* Information regarding the total cost of wheat production per acre was presented in (Table 2) Results show that the average spending on total cost items was Rs. 75203.591/acre in 2022 which were higher as compared to the previous year and it was Rs. 49173/acre during 2021.

**Table 2:** Cost of production/acre.

Cost of production/acre	2021	Total cost	Mean	Stdev. Deviation
Variable cost (Capital+labor cost)		39173	3752.19	7679.21
Fixed cost		10000	-	-
Total cost		49173		
Variable cost (Capital +labor cost)	2022	53403.676	17142.33	12198.199
Fixed cost		14999.994	15000	3565.691
Total cost		68403.67		15763.89

*Yield analysis:* Depending upon soil fertility, input cost, and the use of inputs, the wheat yield varied between 20 to 35 mounds per acre and 20 to 38 mounds per acre during the period of 2021 and 2022. The average wheat yield in the study area was estimated as 30.34 mounds per acre in 2022. in 2022 8 mounds/acre yield decreases as compared to the previous year. Information regarding yield is presented in the (Table 3).

*Market price analysis:* In 2022, the average sale price of wheat was found to be Rs. 2150 per mound. However,

er, the minimum and maximum sale prices were Rs. 1270 and Rs. 2200 per mound. However, average sale price in 2021 were Rs. 1300. In comparison of 2021 market price is high in 2022 (Table 4).

**Table 3:** Per acre average yield in mounds.

Yield (Mounds)	Average yield	Minimum	Maximum	S.D.
2020-21	38.13	20	60	6.69
2021-22	30.34	20	35	7.49

**Table 4:** Market price of wheat during 2022.

Market price (Rs.)	Sale price	Minimum price	Maximum price
2021	Mean 1300	1200	1800
2022	2150	1300	2200

**Table 5:** Yield, Sale Price, Gross income, Total Income, and Gross margin analysis during 2021–2022.

Yield/acre	Average	
	2021	2022
Wheat yield (mounds)	39.11	37.64
Market sale price Rs./40 kg	1350	2150
Total cost	49173	68403.67
Total Income from wheat/Gross income (Rs.) per acre	70270.96	80281
Net Return (Rs.)	21097.96	11877.33

*Net income and gross return of wheat:* Information regarding the net return and gross margin per acre of wheat is presented in the following (Table 5). The average wheat yield in the study area was estimated as 37.64 mounds per acre. The gross income per acre from wheat production was calculated as Rs. 80281. The gross margin, which is the difference between the gross income and variable cost was found to be Rs. 68403.67 per acre while net returns were calculated as Rs. 11877.33 per acre. Results indicated that wheat yield and net return was high in 2021 as compared to this year.

*Benefit-cost ratio:* The value of BCR for this study is 1.17 (Table 6) which is greater than one. It implies farmers are earning more than they are spending on wheat production. If the farmers spend one more rupee on the production of wheat they will get revenue at the rate of 11.7 %. results shows that in 2021 farmers earn more than 2022 from wheat crop.

**Table 6:** Cost-benefit ratio analysis of wheat per acre during 2022.

Area was sown	Net income (Rs.)	Total expenditure	A/B=C	Year
1 acre	80281	68403.67	1.17	2022
	70270.96	49173	1.42	2021

**Table 7:** Lesson learn from this crisis.

Questions	Yes		No	
	F	%	F	%
I will purchase fertilizer even before sowing	44	41.9	61	58.1
Due to crisis, have you changed the fertilizer application method?	67	63.8	38	36.2
Do you think that the fertilizer prices are compatible with current wheat price?	17	16.2	88	83.8

*Constraints faced by wheat growers:* Analysis of study shows (Table 7) that farmers are confronted with agronomic, environmental, and economic constraints. But economic constraints are more problematic for them than other constraints. The fertilizer prices affect the farm input and output ratio. Results show that 81.82 percent of the fertilizers prices affect the purchase of fertilizers. Farmers suffered fertilizer cost which constitutes the highest 62.7 percent average percent losses. Survey shows that 100 percent of the respondents are not satisfied with the purchase prices of fertilizers. It was observed that 88.18 percent of the farmers were not satisfied with the current prices of fertilizers in the market. About 58.18 percent of them purchased fertilizers after sowing of wheat crop.

Quality of fertilizer plays an important role to enhance crop production and soil nutrient quality. About 68.18 percent of the wheat-growers have used alternative nutrients to overcome the deficiency of fertilizer at their farms. The minimum and maximum losses of the fertilizer are 5 and 25. The quality of wheat seed is medium, and its average percent losses are 4.85. The cost of seed is high for the farmers are they suffer an average of 9.73 percent losses due to high seed cost. Water shortage and yield variability are low in the studied area, and it has an average of 3.94 and 4.12 percent losses respectively.

Fertilizer quality, pesticide quality, disease incidence, and pest attack are low to medium in sampled farms. Many of the farmers in the Faisalabad applied late

fertilizer in 2022 year due to the shortage of fertilizer, not timely availability of fertilizer and high fertilizer prices. Results show that 38.18 and 44.55 percent of the respondents showed good and satisfactory responses towards wheat production risk while 17.27 percent of the respondents showed a poor response to wheat production due to the high cost of production. Results show that 43.64 and 56.36 percent of the farmers respond that the yield variability ratio among farmers is moderate and low. More than 70 percent face less and moderate levels of price variability while 28.19 percent of the farmers face constraints due to high price variability in wheat crops.

**Table 8:** Results of Random-Effect Regression Model.

	Coefficient	Std. Err	P>t
Constant (yield)	32.65	.6269	0.7
Age	.0979	.0546	0.073
Education	.0172	.1800	0.924
Wheat farming experience	.06333	.05615	0.259
Seed quantity	.1850	..1078	0.086
Urea quantity	-.3715	1.0748	0.730
AN quantity	.2347	1.1535	0.839
DAP quantity	-2.2728	2.7946	0.416
NPK quantity	-1.9401	1.3957	0.165
Pesticide quantity	-1.8363	1.7577	0.296
Market price	.0089	.0028054	0.002

Farmers are more conscious about timely purchase of fertilizer for better crop productivity. Survey results reveal that 58.1 percent of the farmers purchase fertilizer after sowing, while 41.9 percent of the farmers purchase before sowing. One of the reasons of late application of fertilizer is fertilizer shortage crises. Results regarding fertilizer crises in the study area show 36.2 percent of the farmers change fertilizer application method followed by 63.8 percent of the respondents do not change their fertilizer application method in wheat cultivation. Fertilizer prices are one of the major variables in dropping wheat yield. Survey results shows that majority of the farmers respond that fertilizer prices are not compatible with current prices.

*Quantify impact of factors effecting wheat productivity:* (Table 8) presents results for Random-effect regressions with yield per hectare as the dependent variable, covering two-years data. Pooled GLS with year dummies are used. All the independent variables are (age, education, wheat farming experience, seed quantity, urea, AN, DAP, and NPK quantity, pesticide quantity,

and market price while, dependent variable is wheat yield. The coefficient on urea, DAP, NPK, pesticide quantities are strongly significant. All the independent variables except (age, education, AN quantity and market price have a positive impact on wheat yield. While other variables have their negative coefficient values. Among them, DAP quantity has the highest coefficient value of -2.27 which means increase in DAP bag price decrease per acre DAP quantity in 2022 also decreased the wheat yield by 2.27 as compared to the previous year. Similarly, urea, NPK, and pesticide quantities have their negative coefficient values. The values of the coefficient of urea, NPK and pesticide quantities are -.3713, -1.9401, and -1.8368 which shows that when this fertilizer cost is increased by one rupee it tends to decrease wheat yield by -.3713, -1.9401, and -1.8368 mounds per acre in 2022 as compared to the recent year. Fertilizer cost and market price has a larger significant effect on wheat yield in 2022. The value of the ammonium nitrate coefficient is positive shows there is no significant increase in wheat price and quantity application in 2022, which exhibit that increase by one unit it tends to increase wheat by 0.2347 mounds per acre in 2022. The value of the coefficient of farm farming experience is 0.0633 which shows that farmers of more age have more farming experience and tend to increase wheat yield by 0.0633 mounds in 2022. It has a significant effect on wheat yield. Variables of age and education have a significant impact on wheat yield. Their coefficient values are better than other coefficient values. The value of the coefficient of wheat market price is 0.0089 which shows that market price of wheat is higher in 2022 as compared to 2021. The results of regression of 2021-2022 time fall has larger significant effect on wheat yield. The empirical results confirm that the wheat yield was declined in 2022 as compared to 2021 time period which shows that productivity of wheat was declined 36 percent in 2022 as compared to the previous year because fertilizer and pesticide prices increases our farmer cannot afford these inputs at higher prices.

The overall results of Random-effect regression model showed various independent variables have a different impact on wheat yield. The results of random effect regression of 2021-2022 time fall has larger significant effect on wheat yield as compare to the previous year. The empirical results confirm that the wheat yield was declined in 2022 as compared to 2021 time fall shown in the following Table.

Random-Effect Regression Model:

$$Y_{it} = \beta_0 + \beta_1 X1_{it} + \beta_2 X2_{it} + \beta_3 X3_{it} + \dots + \alpha_1 D1_{it} + \alpha_2 D1X2_{it} + \alpha_3 D1X3_{it} + \alpha_4 D1X7_{it} + \alpha_5 D1X8_{it} + \alpha_6 D1X9_{it} + \alpha_7 D1X10_{it}$$

Random-effects GLS regression; Number of obs = 219; Group variable: index; Number of groups = 2; R-sq: within = 0.3610; Obs per group: min = 109; between = 1.0000; avg = 109.5; overall = 0.9053; max = 110.

## Conclusions and Recommendations

Analysis regarding the socioeconomic status of the respondents says that majority of the farmers in the study area are less educated, experienced and have an average age of 40 years, with an average house hold size of 7, and average farming experience of 22 years. The main conclusion drawn from the findings is the fact mostly farm inputs have a positive impact except for seed, fertilize, pesticide costs, and land rent have a negative impact on the production of wheat in the study area. Increased use of farm inputs is positively and significantly associated with yield. Among the cost items fertilizer, land rent and land preparation cost account for the largest variable of wheat production in the Faisalabad region. The average gross revenue generated was reported to be Rs. 68367.67 per acre while the total net income generated from per acre was Rs. 12240.33. The benefit-cost ratio of wheat yield was 1.17 showed the net return of the farmers is greater than their costs. The constraints associated with the wheat production in the study area are shortage of fertilizer, high fertilizer prices (urea, DAP, NPK), not timely availability of fertilizer, inadequate finance, availability of canal water, high cost of production, high cost of labor and ineffective role of agricultural agents. This study shows that increasing fertilizer prices led to decreasing fertilizer use for wheat production and wheat yield in 2022 by increasing fertilizer prices to wheat producer price ratio.

According to the above findings following recommendations and suggestions were made:

- Input-output prices is the major component of profitability. The findings suggest that the sale price of wheat is low for the farmers. The sale prices of wheat should be increased which will not only increase the income of farmers but it will also become the motivation for the farmers to produce

more in the future.

- To boost the capacity of marginal and small farmers purchased fertilizer at an affordable price level and government policy support is required.
- The major cause of the droop in wheat productivity is a corresponding decrease in the area planted with wheat due to the high cost of production expenditures, and a reduction in fertilizer use because of its high cost.
- The fertilizer-to-wheat parity ratio has declined as a result fertilizer prices raising proportionately faster than the support prices of wheat. Therefore, immediate action is needed to decrease the market pricing of fertilizer for wheat. This can be accomplished by cutting fertilizer cost or by supporting wheat by increasing its support price.

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## Novelty Statement

This Study is new and adding to literature a scientific proof of overtime and dynamic effects of changing prices on use of fertilizer and its impact of yield.

## Author's Contribution

**Sadia Rashid:** Data collection and analysis, and initial draft write up under corresponding author's supervision

**Muhammad Waqas Alam Chattha:** Developed the concept of research, finalized research tools and methodology and scientific write up.

**Almazea Fatima:** Supervised research for analysis, questionnaire built up, and writing of results and discussion section.

**Muhammad Farooq Hyder:** Verification and cleaning of data, supervising scientific data entry

**Nazia Tabasam:** Verified and supervised proper review to back up the scientific study and to contribute to literature

## Conflict of interest

The authors have declared no conflict of interest.

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