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# Economic Effects of Fertilizer Subsidy on Major Crops Productivity in Pakistan

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**ABSTRACT**

Based on time series data set (1990-2022) this study was conducted to estimate the economic effects of fertilizer subsidies on major crops productivity in Pakistan. Majority (90%) of the farmers having small land holding size are not in a position to apply inputs like fertilizer which incurred 15-20% of total cost of production. Three types of analysis were employed i.e., Trend analysis, Correlation analysis and Regression analysis. The trends in growth rate of fertilizer use along with trends in growth rate of respective crop yield have been sketched with different trends. The correlation analysis between fertilizer subsidy and yield (kg $ha^{-1}$) of major crops i.e. wheat, rice, sugarcane, cotton and maize has been calculated with positive correlation coefficient values as 0.459, 0.468, 0.351, 0.224 and 0.551 respectively. The simple linear regression analysis depicted that a rupee of one billion PKR subsidies is significantly increased the crop fertilizer usage (000 tons nutrients) of wheat (37.10), rice (14.97), sugarcane (13.60) and cotton (40.12) as well as increased the crop yield (mound $acre^{-1}$) of wheat (0.26), rice (2.04), sugarcane (32.93), maize (62.17) and cotton (0.19) respectively which indicated that the yield of the crops is also positively affected by fertilizer use and fertilizer subsidy. The elasticity of yield with respect to fertilizer subsidy also confirmed the regression analysis results. Although yield is inelastic to subsidies; however, one % increase in fertilizer subsidy resulted in 0.043, 0.061, 0.044, 0.022 and 0.207 (%) increased in yield of wheat, rice, sugarcane, cotton and maize respectively. Based on positive values of coefficients, it is concluded that the fertilizer subsidies should be distributed more efficiently to enhance the productivity of crops.

**Keywords:** Economic, Fertilizer, Productivity, Regression, Subsidy, Time Series, Yield.

## INTRODUCTION

In Pakistani economy the share of Agriculture sector has been recorded with 22.9% in GDP and 37.4% in employment, which plays a significant role of raw material provider to industries, food security and foreign exchange reserve. During FY 2022-23 the production growth of sugarcane (2.8%), maize (6.9%) and wheat (5.4%) compensated for the negative growth of rice (-21.5%) and cotton (-41.0%) for subsequent previous year (GOP, 2023c). The majority of the farmers (90%) are not in a situation to arrange costly inputs due to budget constraints. Hence, crop sector growth remained lower than potential levels. As a result, subsidies on inputs like seed, plant protection and fertilizer has significance. United States; a developed country has also provided several subsidized schemes to farmers that help progress their farm produce. A subsidy is provided basically to ensure farmer's profitability, stabilize market prices, food security and sustainable agriculture (Ricker and Jayne, 2009; Bunde *et al.,* 2014; Sibande *et al.,* 2015).

The type of subsidy differs by country to country and crop to crop; like (1) direct cash payments; (2) price supports regarding government procurement and storage; (3) regulations that set minimum prices by location, end use, or some other characteristic; (4) subsidies for such items as crop insurance, disaster response, credit, marketing, and irrigation water; (5)

export subsidies; and (6) import barriers in the form of quotas, tariffs, or regulations. Often, supply control programs such as land-idling requirements, production quotas, or similar schemes accompany price supports or other programs (Sumner, 2008). The farmers with small land holdings directly gained fruits with fertilizer subsidy by purchasing costly fertilizer input which has significant impact on yield. Naqvi *et al.,* (1989) explained that when the prices of fertilizer were increased by 50% during 1980s, the farmers having small land decreased the usage of fertilizers by 54% as compared to the farmers having large land holding size. Similarly, Chuadhry *et al.,* (1993) concluded the same trends regarding irrigating the crops upon increased intensity-based water prices.

The balanced and efficient application of fertilizer has enhanced the crop productivity up to 50%. As per research 8 kg of grain (rice, maize and wheat), 114 kg of sugarcane and 2.5 kg of cotton may be produced by applying one kg of fertilizer nutrient. In Pakistan the soil is deficient in nutrients like about 80-90% soil is deficient in phosphorus (P) and 30% in potassium (K). Soil fertility is constantly declining due to withdrawal of vital plant nutrients from the soils as a result of intensive cultivation (Danish *at al.,* 2017).

During 1950s the Govt. of Pakistan initiated the subsidy on synthetic fertilizers with the objective to increase its usage; however, during 1960s the size of subsidies on inputs was enlarged. According to Kuhnen *et al.,* (1989) in late 1960s the seed, machinery, fertilizer, insecticides and canal irrigation were supplied to farmers at subsidized rates. In the 1970s, the Govt. reduced the scale of subsidies on inputs due to peak in fuel prices, Indian war, and depreciation of Pakistani currency (PKR) (Chaudhry *et al.,* 1995). Other country like Indian Govt. is also providing inputs on subsidized prices. During 1980-81, India has granted the subsidy of PKR 4.7 billion on fertilizer which was enhanced to PKR 95 billion in 2000-01 and PKR 309 billion in 2008-09, respectively. During FY 2016-17, the India has initiated a pilot basis system of Direct Benefit Transfer (DBT) for subsidy on inputs like fertilizer (Danish *at al.,* 2017).

The fundamental ground of subsidy is to financially uplift the small or marginal farmers; regarding this Pakistan has announced a huge amount (PKR 30 billion) on imported urea fertilizer. During FY 2021-22 Govt. of the Punjab has initiated E-Voucher Based Fertilizer and seed Subsidy programs. In this program the subsidy has been granted on fertilizers like Single super-phosphate (SSP), Sulphate of potash (SOP), Di-ammonium phosphate (DAP), Nitrophos (NP), Muriate of potash (MOP) and Nitrogen-phosphorus-potassium (NPK) as PKR 200, 800, 500, 200, 500 and 300 on per 50Kg bag basis (GOP, 2023a). Consequently, the farmers with large land holdings always obtain a massive quantity of subsidy as they applied more fertilizers. Hence, targeted subsidy must be issued to benefit the poor and marginal farmers. Also during the distribution process, the measure of soil fertility status must be considered to enhance the yield of crops.

The subsidies on inputs like fertilizer can affect the prices, demand, supply and productivity of agriculture products. Before this study Chaudhry *et al.,* (1995) and Khan *et al.,* (2010) has explained the impact of fertilizer prices and subsidy to increase the crops production in Pakistan. Similarly, Naimatullah *et al.,* (2010) concluded the positive effects of support price of fertilizer on acreage of crops like rice and wheat. Therefore, this study was designed to estimate the economic effects of fertilizers subsidy on productivity of major crops in Pakistan.

## MATERIAL AND METHODS

During the year 2022 this study was conducted to estimate the economic effects of fertilizer subsidy on productivity of major crops in Punjab, Pakistan. Time series data (1990-2022) was used for the simple regression analysis on variables like crops yield, fertilizer usage for crops and provided fertilizer subsidies. The required secondary data acquired from published sources like Bureau of Statistics, Economic Survey of Pakistan, National Fertilizer Development Centre Islamabad, Crop Reporting Service, Agriculture Department Punjab, Pakistan. Accordingly, three types of analysis were employed i.e., Trend analysis, Correlational analysis and Regression analysis.

The trend analysis was carried out by making a comparison of the variables i.e. growth rate of fertilizer used and growth rate of yield of major crops. Line chart was employed to project the trends. Correlation analysis was employed to test the bi-variate association between two variables. The coefficients with higher value represent the stronger relation between the variables. Pearson correlation test was used to test the multicollinearity with possible values of +1 and -1 which represents the perfect positive and perfect negative linear relationship respectively; otherwise, coefficient

values between +1 and -1 shows the level of dependence accordingly (Pearson, 1896). The formula used is described as under: -

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

$r$ = correlation coefficient

$x_i$ = values of the x-variable in a sample

$\bar{x}$ = mean of the values of the x-variable

$y_i$ = values of the y-variable in a sample

$\bar{y}$ = mean of the values of the y-variable

Where,

Five major agriculture crops (rice, wheat, cotton, maize and sugarcane) yield, production and fertilizer usage parameters were considered while taking into count this research study. Ramli *et al.,* (2012) estimated the impact of fertilizer subsidy on the productivity of rice crop in Malaysia by employing the same model. Latif and Ashfaq (2013) adopted the same equation for estimating the economic impact of remittances in rural economy. The simple linear regression analysis model specified for this research purpose is as:

$$\mathbf{Yi = \beta_0 + \beta_1 X_1 + \mu}$$

Where $Y_i$ expresses dependent variable like crop wise yield. Here different models were measured to empirically investigate the relationship between independent variable ($X_1$) like fertilizer subsidy on dependent variable ($Y_i$). The slope/coefficient of the variables relationship/lines is $\beta_1$ and constant coefficient is $\beta_2$ while $\mu$ is error factor.

In the linear regression model, the concept of elasticity (Hayat et al., 2023) can be computed by using the following formula to confirm the results of regression analysis:

$$\mathbf{e_{xy}} = \widehat{\boldsymbol{\beta}} \frac{\bar{X}}{\bar{Y}}$$

Where; ßˆ is the estimated coefficient of respective regression, $\bar{x}$ is the mean value of independent variable (fertilizer subsidy) and $\bar{Y}$ is the mean value of dependent variable (yield).

## RESULTS AND DISCUSSION

The factors like land preparation through plough and rotavator, planking, irrigation, fertilizer usage like DAP and urea, farmyard manure, crop varieties, seed treatment, weedicide application, pesticides for diseases and pests were found as significant factors for higher yield of all crops (Shah *et al.,*2020).

About 15-20% of cost has to incur for fertilizers to produce crops. The fertilizer cost PKR/acre (with% share in total cost of production) for wheat, sugarcane, rice (basmati), rice (non-basmati), maize (hybrid) and cotton were calculated as 14704 (20.56%), 23411 (16.57%), 11593 (16.37%), 10645 (15.83%), 15490 (19.36%) and 11826 (15.37%) respectively (GOP, 2023b). The detail of fertilizer cost has been depicted in figure 1.

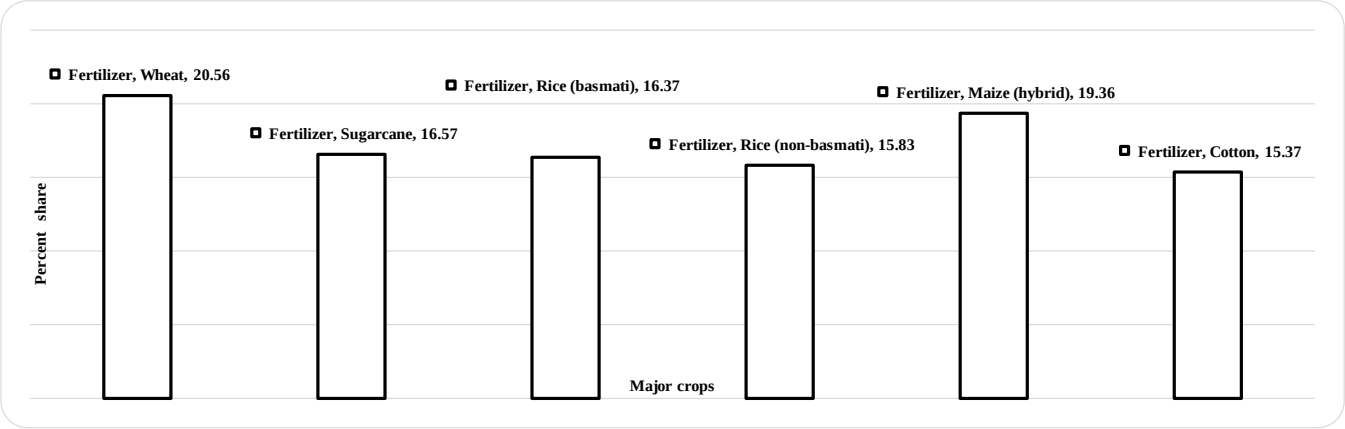



Figure 1. Percent share of Fertilizer cost in total cost of production.

### Trend Analysis

The area and yield of the major crops i.e., wheat, rice, cotton, sugarcane and maize are below the targets against the alarmingly increasing population growth rate of Punjab (2.13%) and Pakistan (2.40%) (GOP, 2018). Furthermore, the lower yield (mound acre$^{-1}$) of wheat (32), rice (23.43), cotton (10.50), sugarcane (722) and maize (69.20) have been recorded in Punjab, Pakistan (GOP, 2023b).

The possible grounds for lower yield of major crops may

be the lack of high yielding varieties, climate change, insufficient increase in support prices, high cost of production due to expensive inputs like seed, fertilizer, fuel etc., lack of farm mechanization, labor shortage, uneconomic land holding and declining agricultural land rapidly due to urbanization etc. As 15-20% of total cost of production is calculated with fertilizer cost and farmers applied the under dosed fertilizer as depicted by field surveys conducted by Adaptive Research Farm, Gujranwala from time to time. Similarly, 7-15% of total cost of production is estimated with seed cost. Thus, there may be great scope to enhance productivity of crop sector by more subsidizing the inputs like fertilizer and seed. Based on data set comprising 1990-91 to 2020-21 the mean fertilizer subsidy (PKR bn./year) for wheat, rice, sugarcane, cotton and maize were computed as 4.548, 0.551, 0.732, 2.270 and 0.144 respectively. Meanwhile the mean yield (mound acre$^{-1}$) per annum for wheat, rice, sugarcane, cotton and maize were computed as 27.50, 18.34, 547.13, 19.57 and 40.86 respectively (Table 1).

Table 1. Descriptive Statistics on fertilizer subsidy and yield based on time series data (1990-2022).

| Parameter | Mean | Std. Deviation |
|---|---|---|
| Fertilizer subsidy (PKR bn.) for Wheat | 4.548 | 6.647 |
| Fertilizer subsidy (PKR bn.) for Rice | 0.551 | 0.794 |
| Fertilizer subsidy (PKR bn.) Sugarcane | 0.732 | 1.061 |
| Fertilizer subsidy (PKR bn.) for Cotton | 2.270 | 3.326 |
| Fertilizer subsidy (PKR bn.) for Maize | 0.144 | 0.199 |
| Yield (mound acre$^{-1}$) of Wheat | 27.500 | 3.735 |
| Yield (mound acre$^{-1}$) of Rice | 18.344 | 3.459 |
| Yield (mound acre$^{-1}$) of Sugarcane | 547.130 | 99.378 |
| Yield (mound acre$^{-1}$) of Cotton | 19.573 | 2.885 |
| Yield (mound acre$^{-1}$) of Maize | 40.863 | 22.447 |

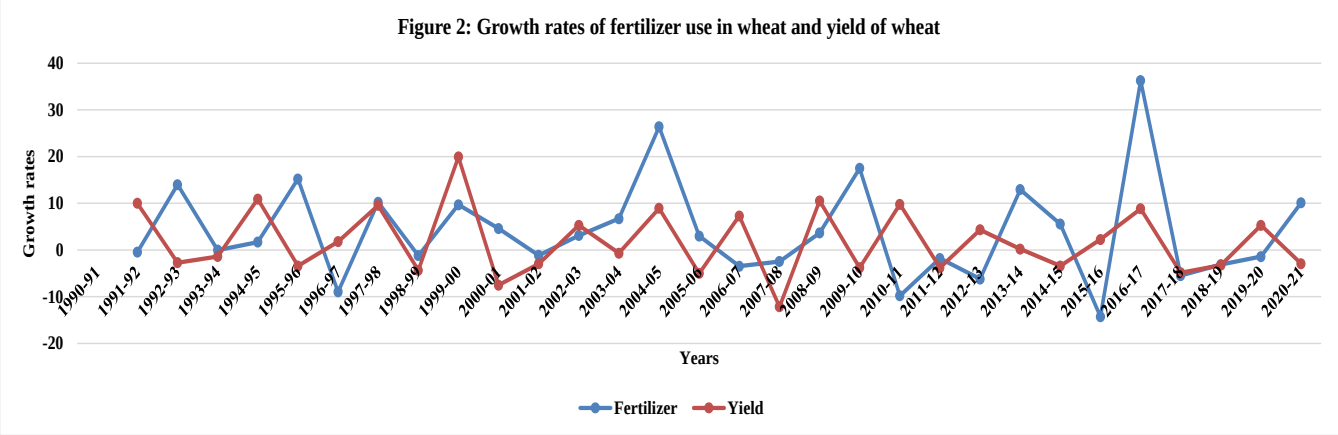
Fertilizers improve the water holding capacity of the plants and increase root depth. The potassium content present in the fertilizers strengthens the straws and stalks of the plants. The phosphorus present in the fertilizers helps in the faster development of roots and formation of seeds in the plants. In fertilizers, nitrogen enhances the growth of the plants which can be characterized by the green colour of the plants (ALnaass *et al.,* 2021).

Ali *et al.,* (2019) explained that the fertilizer subsidy program enabled 80% of the farmers to apply recommended doses of fertilizers timely, and also incentivized the farmers to bring more area under cultivation. As a result of subsidy, the wheat yields are higher in the range of 65–71 kg per hectare while the rice yields are higher in the range of 34–43 kg per hectare.

The trends in growth rate of fertilizer use in crops (i.e., wheat, rice, maize, cotton and sugarcane) along with trends in growth rate of respected crops yield have been sketched. Figure 2 displays growth of fertilizer use in wheat and growth of wheat yield, showed volatile or non-linear relationship between the growth rates of fertilizer use and wheat yield.

Self-sufficiency in wheat being staple food grain has been a goal of every regime and thus always challenges for the agriculture experts and policy makers; during 2021-22 wheat production declined (3.9%) due to decline in area sown, shortfall in irrigation water and drought conditions at sowing (November-December month with zero rainfall), less fertilizers off take due to short supply as well as price hike and heat wave in March/April, though the government has increased minimum support price to PKR 2200/40 kg for 2022 (GOP, 2022).

During the year 2022-23 wheat contributed 8.2% value added in agriculture and 1.9% to GDP. It was cultivated with increase of 0.7% area subsequently a growth of 5.4% was resulted in wheat production as compared to last year. Wheat production enhanced as the government has increased Minimum Support Price to PKR 3900/40 kg compared to PKR 2200/40 kg ensuring better economic returns to alleviate higher input cost (GOP, 2023c).




Growth rate of fertilizer use in rice and growth rate of rice yield is displayed in figure 3, showed inconsistent or weakly correlated trend. The growth rate of fertilizer use flocculate significantly while the rice yield remained relatively stable over time.

During the year 2022-23 rice contributed 1.9% value added in agriculture and 0.4% to GDP. During the last few years, production of coarse types is increasing as the farmers are bringing more areas under coarse hybrid types. It was cultivated with decrease of 15.9% area subsequently a decline of 21.5% was resulted in rice production as compared to last year. This less production in combination with high input prices has caused increase in paddy price (GOP, 2023c).

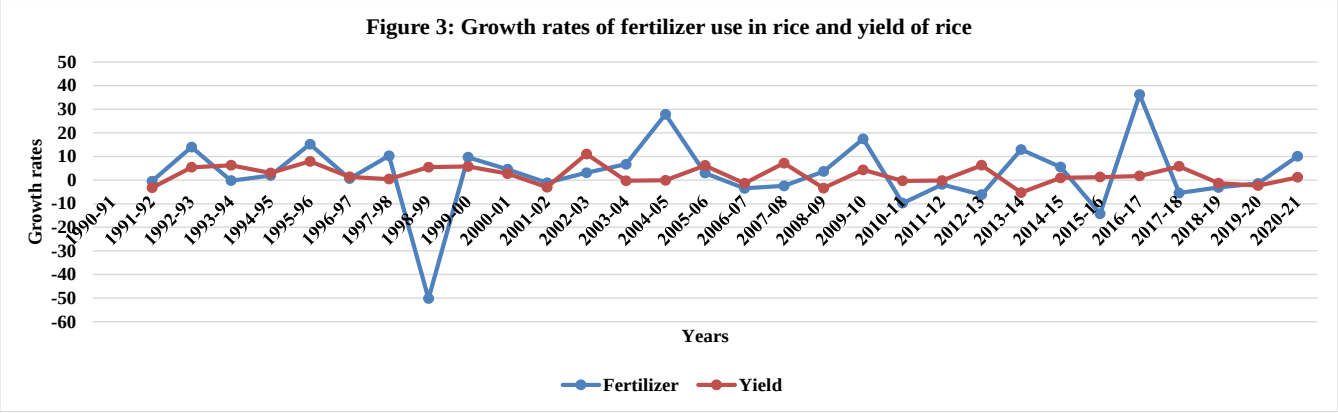



Figure 4 exhibits trends in growth rates of fertilizer use in maize and growth rate of maize yield. Figure displays that as the fertilizer use in maize is increasing or decreasing, its yields is not growing or declining with same proportion and also showing some negative trends in some years. Like from 1997-98 to 1999-2000 the fertilizer usage was declined while yield of maize was in increasing trend. Similarly, 2003-04 to 2005-06 the fertilizer usage was declined while yield of maize was in increasing trend. However, from 2015-16 to 2017-18 the fertilizer usage was increased while yield of maize was in decreasing trend.

During the year 2022-23 maize contributed 3.0% value added in agriculture and 0.7% to GDP. It was cultivated with positive growth of 4.1% area subsequently an increase of 6.9% was resulted in maize production as compared to last year. This increase in production was mainly due to increase in area sown, use of high yielding seed and subsidized fertilizer (GOP, 2023c).

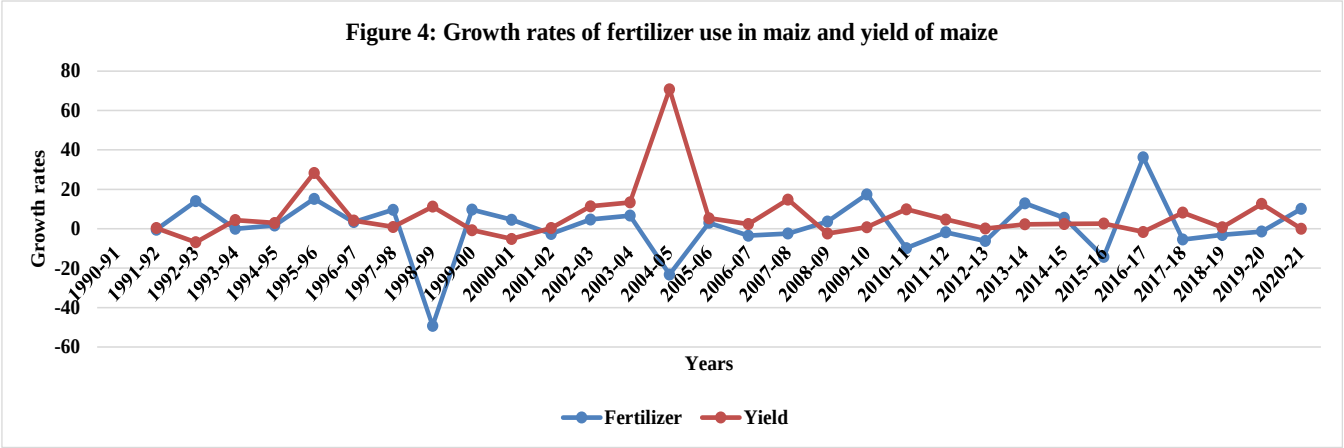
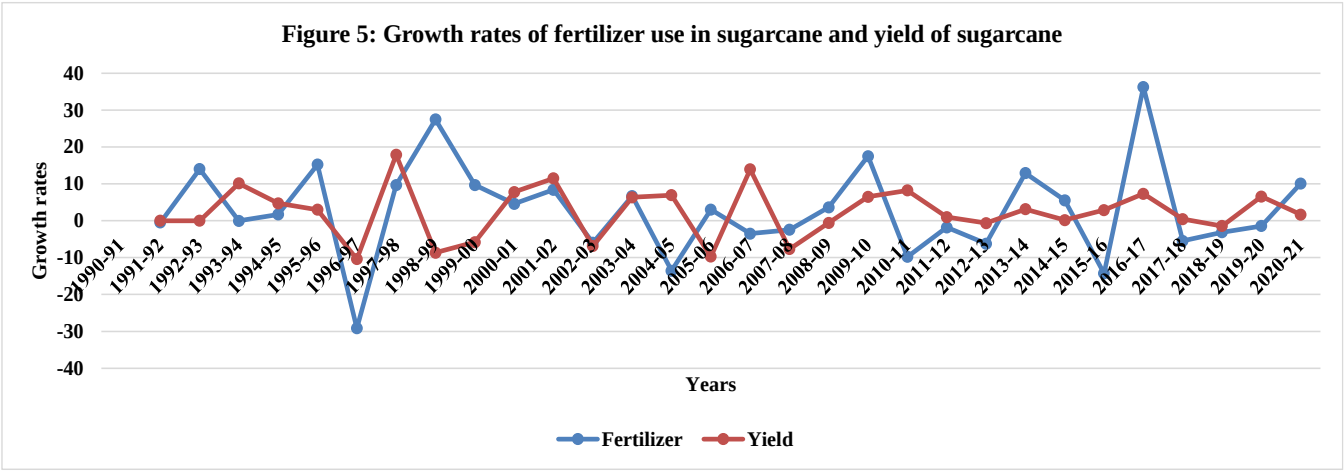


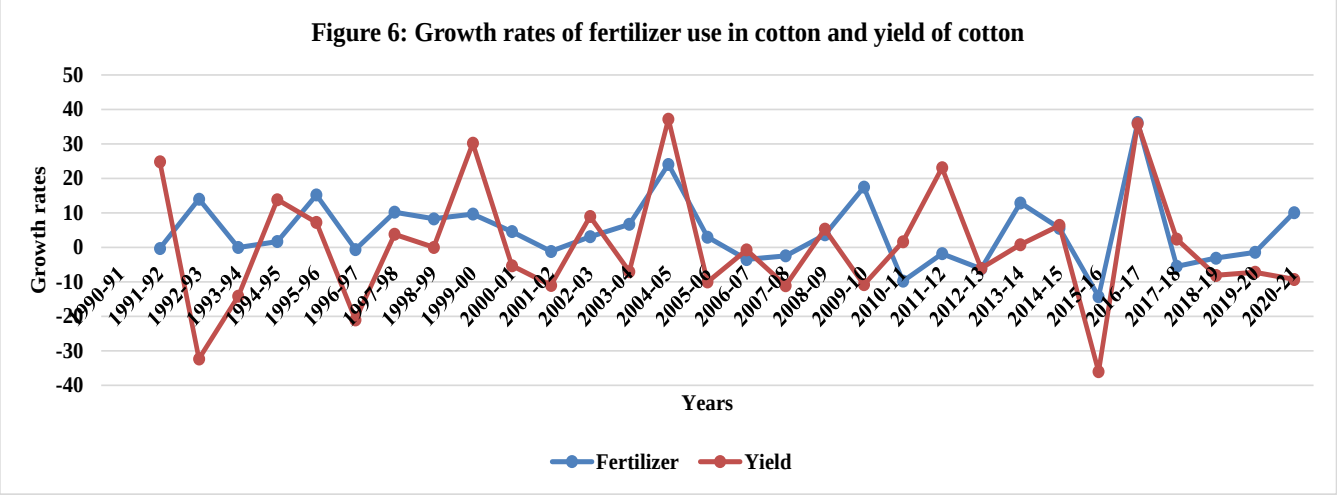

Figure 5 exhibits trends in growth rates of fertilizer use in sugarcane and its growth rate of yield. Starting from 1996-97 to 1997-98, graph is showing somewhat negative bilateral trends, in most subsequent periods, these trends are moving in same direction.

Sugarcane is a tropical crop cultivated generally in Punjab, Sindh and Khyber Pakhtunkhwa. It provides raw material to the second main agro based sugar industry over the country. During the 2022-23 sugarcane contributed 3.7% value added in agriculture and 0.9% to GDP. It was cultivated with positive growth of 4.7% area subsequently an increase of 2.8% had resulted in maize production as compared to last year (GOP, 2023c).




Trends in growth rates of fertilizer use in cotton and growth rate of cotton yield are exhibited in figure 6. It exhibits that as the fertilizer use in cotton is growing, growth of cotton yield is also growing in same direction, but these trends are heterogeneous.

During the year 2022-23, cotton crop is drastically damaged due to the climatic changes. Cotton season started with the 7-10$^0$C rise in temperatures from the last few years in months of March till May coupled with shortage of irrigation water, causing severe heat wave, which affected cotton germination, seedlings growth and leaf wilting problem. During the year 2022-23 cotton contributed 1.4% value added in agriculture and 0.3% to GDP. It was cultivated with positive growth of 10.7% area but consequently a decrease of 41% had resulted in cotton production as compared to last year. In Punjab, cotton producing districts Rajanpur, DG Khan and Taunsa were worst hit and damaged the cotton crop. Moreover, insect pests, especially pink bollworm, Whitefly and Thrips remained prevalent during the season (GOP, 2023c).




**Correlation Analysis**

The correlation analysis between fertilizer subsidy and the respective crop yield (kg ha$^{-1}$) in Pakistan has been described based on data 1990-91 to 2020-21. The correlation analysis of fertilizer subsidy and yield of wheat in kg ha$^{-1}$ has been calculated with value of correlation coefficient as 0.459 which indicated that the concerned variables are positively correlated to each other. The results suggest that if the government increases the fertilizer subsidy, then it will increase the yield of wheat and vice versa. The value of correlation coefficient between fertilizer subsidy and yield of rice resulted as 0.468 which indicates that the variables are positively correlated to each other. The correlation coefficient between fertilizer subsidy and yield of sugarcane has been recorded as 0.351 positively. The results suggest that if the government increases the fertilizer subsidy, then it will increase the yield of sugarcane and vice versa. The correlation coefficient between fertilizer subsidy and yield of cotton has been recorded as 0.224 positively. Fertilizer subsidy is positively correlated with the yield of maize; however, a negative relationship has been indicated through regression analysis.

Table 2. Correlations Analysis on fertilizer subsidy and crop yield.

| | | | | |
|---|---|---|---|---|
| 1 | Correlations for Wheat | | Subsidy for Wheat | Yield of Wheat |
| | Subsidy for Wheat | Pearson Correlation | 1 | 0.459** |
| | | Sig. (2-tailed) | | 0.009 |
| | Yield of Wheat | Pearson Correlation | 0.459** | 1 |
| | | Sig. (2-tailed) | 0.009 | |
| 2 | Correlations for Rice | | Subsidy for Rice | Yield of Rice |
| | Subsidy for Rice | Pearson Correlation | 1 | 0.468** |
| | | Sig. (2-tailed) | | 0.008 |
| | Yield of Rice | Pearson Correlation | 0.468** | 1 |
| | | Sig. (2-tailed) | 0.008 | |
| 3 | Correlations for Sugarcane | | Subsidy for Sugarcane | Yield of Sugarcane |
| | Subsidy for Sugarcane | Pearson Correlation | 1 | 0.351 |
| | | Sig. (2-tailed) | | 0.053 |
| | Yield of Sugarcane | Pearson Correlation | 0.351 | 1 |
| | | Sig. (2-tailed) | 0.053 | |

| | | | | |
|---|---|---|---|---|
| 4 | Correlations for Cotton | | Subsidy for Cotton | Yield of Cotton |
| | Subsidy for Cotton | Pearson Correlation | 1 | 0.224 |
| | | Sig. (2-tailed) | | 0.227 |
| | Yield of Cotton | Pearson Correlation | 0.224 | 1 |
| | | Sig. (2-tailed) | 0.227 | |
| 5 | Correlations for Maize | | Subsidy for Maize | Yield of Maize |
| | Subsidy for Maize | Pearson Correlation | 1 | 0.551** |
| | | Sig. (2-tailed) | | 0.002 |
| | Yield of Maize | Pearson Correlation | 0.551** | 1 |
| | | Sig. (2-tailed) | 0.002 | |

**. Correlation is significant at the 0.01 level (2-tailed).

This section represents the impact of fertilizer subsidies on five major crops (Wheat, Rice, Maize, Cotton and Sugarcane) for Punjab province of Pakistan. Fertilizer subsidies were taken in real form in PKR Billions. Similarly, yield (mound acre$^{-1}$) and fertilizer usage (000 nutrient tones) were considered. Our findings are in line with Ramli *et al.,* (2012), Bunde *et al.,* (2014) and Shivashankar and Uma (2014).

**Regression Analysis**

The simple linear regression between fertilizer usage and fertilizer subsidy showed positive relation for all the crops except maize at 5% level of significance ($p<0.05$). It means that by subsidizing the fertilizer the usage of fertilizer increased due to reduction in cost of fertilizer which enhances the yield and production of crops. A rupee of one billion subsidies is significantly increased the crop fertilizer usage (000 tons nutrients) of wheat (37.10), rice (14.97), sugarcane (13.60) and cotton (40.12).

The simple linear regression between fertilizer subsidy and crop yield also showed positive relation for all the major crops at 5% level of significance ($p<0.05$). It means that by subsidizing the fertilizer the yield of crops increased due to reduction in cost of fertilizer. A rupee of one billion subsidies is significantly increasing the crop yield (mound acre$^{-1}$) of wheat (0.26), rice (2.04), sugarcane (32.93), maize (62.17) and cotton (0.19) respectively. Ramli *et al.,* (2012) also found the positive relation of paddy rice yield with fertilizer subsidies.

There is huge scope to enhance the crop yield and production with increased fertilizer usage. The farmers apply under dosed fertilizer which is one of the main reasons for getting low yield and production. The relationship between fertilizer usage and crop yield showed positive relation for all the major crops except maize at 5% level of significance ($p<0.05$). It means that by increasing the fertilizer use (one thousand ton) significantly increased the yield (mound acre$^{-1}$) of crops as wheat (0.01), rice (0.04) and sugarcane (1.44). Findings of regression are also in line with Ricker and Jayne (2009), who found the positive relation of fertilizer subsidy on planted area and maize production in Malawi. Ekanayake (2009) and Ramli *et al.,* (2012) found positive relation of paddy rice with fertilizer subsidies. Bunde *et al.,* (2014) also examined positive and significant effect of fertilizer subsidies on maize production in Kenya.

**Elasticity analysis of crop yield with respect to fertilizer subsidy**

Elasticity of variable is measured to check the %age change in dependent variable due to an independent variable. In the linear regression model, elasticity can be computed by using the following formula:

$$\mathbf{e}_{xy} = \widehat{\boldsymbol{\beta}} \frac{\bar{X}}{\bar{Y}}$$

Where; ß^ is the estimated coefficient of respective regression, $\bar{x}$ is the mean value of independent variable (fertilizer subsidy) and $\bar{Y}$ is the mean value of dependent variable (yield)

Elasticity of yield with respect to fertilizer subsidies also confirms the results of regression analysis. Although yield is inelastic to subsidies; however, one % increase in fertilizer subsidy is resulting in 0.043, 0.061, 0.044, 0.022 and 0.207 % increase in yield of wheat, rice, sugarcane, cotton and maize respectively. Due to positive sign of coefficients, there is need of the efficiently distribution and allocation of subsidies in agriculture sector.

Table 3. Results of simple linear regression with estimated regression coefficients.

| Model | Dependent variable | Coefficient values | Unstandardized Coefficients | Std. Error | Standardized Coefficients Beta | t | Sig. |
|---|---|---|---|---|---|---|---|
| 1 | Fertilizer usage for Wheat | (Constant) | 1488.76 | 99.22 | | 15 | 0 |
| | | Fertilizer subsidy for wheat | 37.1 | 12.46 | 0.48 | 2.98 | 0 |
| 2 | Fertilizer usage for Rice | (Constant) | 216.64 | 9.56 | | 22.67 | 0 |
| | | Fertilizer subsidy for rice | 14.97 | 9.99 | 0.27 | 1.5 | 0 |
| 3 | Fertilizer usage for Sugarcane | (Constant) | 291.11 | 12.07 | | 24.11 | 0 |
| | | Fertilizer subsidy for sugarcane | 13.6 | 9.47 | 0.26 | 1.44 | 0 |
| 4 | Fertilizer usage for Cotton | (Constant) | 723.05 | 53.72 | | 13.46 | 0 |
| | | Fertilizer subsidy for cotton | 40.12 | 13.49 | 0.48 | 2.97 | 0 |
| 5 | Fertilizer usage for Maize | (Constant) | 74.77 | 3.15 | | 23.77 | 0 |
| | | Fertilizer subsidy for maize | -32.82 | 13.14 | -0.42 | -2.5 | 0.018 |
| 6 | Yield of Wheat | (Constant) | 26.33 | 0.74 | | 35.66 | 0 |
| | | Fertilizer subsidy for wheat | 0.26 | 0.09 | 0.46 | 2.78 | 0.009 |
| 7 | Yield of Rice | (Constant) | 17.22 | 0.68 | | 25.2 | 0 |
| | | Fertilizer subsidy for rice | 2.04 | 0.71 | 0.47 | 2.85 | 0.008 |
| 8 | Yield of Sugarcane | (Constant) | 523.02 | 20.76 | | 25.19 | 0 |
| | | Fertilizer subsidy for sugarcane | 32.93 | 16.29 | 0.35 | 2.02 | 0.053 |
| 9 | Yield of Cotton | (Constant) | 19.13 | 0.63 | | 30.61 | 0 |
| | | Fertilizer subsidy for cotton | 0.19 | 0.16 | 0.22 | 1.24 | 0.227 |
| 10 | Yield of Maize | (Constant) | 31.88 | 4.32 | | 7.37 | 0 |
| | | Fertilizer subsidy for maize | 62.17 | 17.77 | 0.55 | 3.5 | 0.002 |
| 11 | Yield of Wheat | (Constant) | 16.46 | 0.98 | | 16.77 | 0 |
| | | Fertilizer usage for Wheat | 0.01 | 0 | 0.91 | 11.76 | 0 |
| 12 | Yield of Rice | (Constant) | 9.93 | 2.91 | | 3.41 | 0.002 |
| | | Fertilizer usage for rice | 0.04 | 0.01 | 0.48 | 2.95 | 0.006 |
| 13 | Yield of Sugarcane | (Constant) | 112.87 | 58.76 | | 1.92 | 0.065 |
| | | Fertilizer usage for Sugarcane | 1.44 | 0.19 | 0.81 | 7.51 | 0 |
| 14 | Yield of Cotton | (Constant) | 19.28 | 1.66 | | 11.58 | 0 |
| | | Fertilizer usage for cotton | 0 | 0 | 0.03 | 0.19 | 0.852 |
| 15 | Yield of Maize | (Constant) | 94.95 | 16.38 | | 5.8 | 0 |
| | | Fertilizer usage for maize | -0.77 | 0.23 | -0.54 | -3.38 | 0.002 |

Table 4. Elasticity of crops yield with respect to fertilizer subsidy

| Crop | Elasticity value |
|---|---|
| Wheat | 0.043 |
| Rice | 0.061 |
| Sugarcane | 0.044 |
| Cotton | 0.022 |
| Maize | 0.207 |

## CONCLUSION

Majority (90%) of Pakistan's farmers having small land holding size are not in a position to apply key inputs from their own sources. Thus the provision of subsidies on agricultural inputs particularly on fertilizers having 15-20% share in total cost of production is need of the hour. This study was, therefore, designed to explore the economic effects of fertilizer subsidy on major crops' productivity. Correlation analysis indicated the positive correlation between fertilizer subsidy and yield of respective crops. Regression analysis demonstrated that yield of the crop is positively affected by fertilizer use and fertilizer subsidy which is also justified with elasticity analysis.

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