Journal of Statistics, Computing and Interdisciplinary Research
ISSN (P): 2707-7101

J. Stat. Comp. & Interdis. Rese.
Volume 5(2) (2023),29-37
http://scir.wum.edu.pk/index.php/ojs

Analyzing the Impact of Subsectors and Population Growth on Agricultural Sector in Pakistan

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Abstract

The agriculture sector in Pakistan plays its vital role for providing food security and economic stability. Pakistan's agriculture sector comprises various subsectors i.e. crops, livestock, fisheries, and forestry. Agriculture growth is threatened by the growth of these subsectors and the impact of population growth on it. No significant research has been conducted in Pakistan to study the statistical significance of these subsectors and their relationship with population growth. This study analyzes data from 2005 to 2023. Regression analysis is used to identify and to compare the statistical significance of all sub sectors of agriculture growth with population growth rate. Average growth rates found positive for agriculture, major crops, livestock, fisheries, and population, while negative for forestry. Model found good fit with R^2 0.936. Major crops, livestock, and fisheries have positive and statistically significant impacts on Pakistan's agricultural growth, with coefficients of 0.316, 0.426, and 0.015, while forestry and population reported negative and statistically insignificant results with coefficients of -0.019 and -0.273. This research laid out good policy decisions aimed at boosting agricultural growth in Pakistan.

Keywords: Agriculture Growth, Subsectors, Crops, Livestock, Fisheries, Forestry, Population, Regression, Statistical Significance

Introduction

Agriculture sector plays a critical role in providing food and economic stability of Pakistan (Ahmed & Ali, 2023; Islam et al., 2023). Agriculture is a vital pillar of Pakistan's economy, contributing about 22.9% to its GDP and sustaining 37.4% of the labor force (Economic Survey of Pakisatn 2022-23). This sector plays a multifaceted role, encompassing food security,

poverty reduction, industrialization, and economic growth. Pakistan boasts abundant natural resources, primarily arable land, water, various ecological and climatic zones etc. Agriculture sector is significantly contributes to foreign exchange earnings of Pakistan. Pakistan is cultivating about 23.9 million hectares out of its total 79.6 million hectares, constituting 30% of its land area. Pakistan has world's largest adjoining irrigation system, and it has vast agricultural resources, with around 80% of its cultivated area being irrigated (Khan et al., 2006; Siddiqi & Wescoat Jr, 2013). Pakistan is a major producer of various crops and fruits such as wheat, cotton, sugarcane, mangoes, dates, oranges, and rice. In 1947, agriculture contributed 53% to GDP, but it dropped by 19.2% in 2021 (Islam et al., 2023). Despite being an agricultural country, Pakistan lacks modern irrigation and techniques, leading to water loss through leaching and evaporation (Van Steenbergen et al., 2015; Younas & Yaqoob, 2005). Neglect of water management, resulted in salinity and waterlogging. Multiple agriculture issues plague Pakistan's economy, including poor irrigations system, bad infrastructure, traditional farming techniques/methods, poor supply of agriculture inputs and bad financial condition of farmers etc. Despite its impressive agricultural output, Pakistan faces significant food insecurity, affecting half of the population according to the World Food Program (Islam & Shehzad, 2022; Islam et al., 2023; Shiferaw et al., 2013). The increasing population and agricultural production put immense pressure on agriculture sector. Natural and man-made disasters like floods, earthquakes and droughts also effected agricultural growth.

Agricultural sector yields only 1.6% growth rate in 2022-23 and agricultural challenges in Pakistan hinder economic growth (Economic Survey of Pakisatn 2022-23). The major sub sector of Pakistan’ agriculture is crops sector, livestock, fisheries and forestry (Azam & Shafique, 2017; Raza et al., 2012). Important and other crops contributed 18.23% and 14.49% to value addition in agriculture sector with a share of 4.18% and 3.32% to GDP of Pakistan. In 2022-2023, Livestock makes up the largest share, contributed 62.8% to value addition in agriculture sector and 14.36% of the GDP. Over 8 million rural families in Pakistan depend on livestock sector and driving (35-40)% of their income from this sector (Ahmad & Ma, 2020; Ahmad et al., 2020; Hashmi et al., 2021). This sector has the potential to significantly reduce poverty and boost foreign exchange earnings for the country. Forestry and fisheries sector plays a smaller role and contributing 2.23% 1.39% value addition agriculture with 0.51% and 0.32% in GDP of Pakistan. Fisheries are vital for coastal livelihoods and contribute to national income through exports. Forests in Pakistan are vital for the environment and poses socio-economic challenges for future generations. These forests are a source of wood for construction, furniture, carpentry, match production, fiberboard manufacturing, and sports goods (Azam & Shafique, 2017; Najeeb et al., 2023).

Raza et al. (2012) presented the study to identify significance of agricultural sub-sectors with GDP of Pakistan using the simple regression function. They reported all agriculture sub-sectors, except forestry, produced statistically significant results to economic growth of Pakistan. Crops and livestock make up 91% of the total agriculture sector, while fisheries and forestry have minor contributions. Azam and Shafique (2017) presented the study to review the impact the agriculture on economy of Pakistan. This research examined different sub sectors of agriculture i.e. major and minor crops, livestock, fisheries, forestry, and fruits in Pakistan. They highlighted that significant issues in agriculture i.e. water scarcity, poor management, natural disasters etc. was adversely hitting and ultimately leading to slowdown the economic growth. Shahzad (2022) presented the research on Pakistan's dairy industry,

emphasizing its crucial role in sustainable food production. He further highlighted how precision livestock farming can boost productivity and profitability. Chandio et al. (2016) examined Pakistan's agricultural sub-sectors' impact on agricultural GDP using Ordinary Least Square (OLS). They found that major, minor crops and livestock, had significant and positive contribution to agricultural GDP. However, they reported positive, but statistically in-significant impact of forestry on agricultural GDP. This suggests that the forestry sub-sector received less attention from the government compared to other sub-sectors, resulting in a poor performance.

Objective of the Study and Problem Statement

Pakistan is facing a serious concern of dwindling economic growth due to a continuous decline in agricultural growth across the years, resulting in significant losses. No remarkable research has been conducted in Pakistan to identify the statistical significance of specific sub-sector of agriculture i.e. crops sector, livestock, fisheries and forestry, which can contributions to agricultural growth. Such studies could provide valuable insights into the statistical significance of these sectors and help to boost agricultural growth in Pakistan. This research is valuable in guiding the formulation of robust policy recommendations related to the sub-sector contributions to agricultural growth rates in Pakistan along with the impact of population growth rate on performance of agriculture sector. It can be regarded as an exceptional endeavor for the beloved homeland, Pakistan.

Materials and Methods

Source of Data

This study based on secondary dataset, collected from Economic Survey of Pakistan, Ministry of Finance Pakistan for the year 2005 to 2023. The data set based on the growth rates of various sub sector of agricultural i.e. crops sector, livestock, fisheries and forestry along with population growth rates of Pakistan.

Normality in the Data and Descriptive Statistical Analysis

In the field of applied statistics before conducting statistical analysis, it is essential to ensure that data follows a normal distribution. One effective way is to employ graphical presentations. In the present study, we assess the normality of the data through graphical techniques, including histograms with normal curves and P-P plots (Gujarati, 2022; Islam et al., 2021). The mean and standard deviation is applied to measure the averages and dispersion prevails in the datasets.

Multiple Linear Regression (MLR) Model

Multiple linear regressions is applied to endeavor the relationship between agricultural growth and various subsector growth i.e. crops sector, livestock, fisheries and forestry as well as with population growth rate.

$$y_i = \theta_0 + \sum_{i=1}^{m} \theta_i x_i + u$$

Where "y_i" = agriculture growth rate, "θ_0" = regression intercept, "x_i" = sub sector and population growth arts "θ_i" = regression coefficient "u" = residual term.

Hypothesis Testing

This research based on the following hypothesis testing

H_1: The crop sector has significantly impact on Pakistan's agricultural growth rate.

H_2: The livestock sector has significantly impact on Pakistan's agricultural growth rate.

H_3: The fisheries sector has significantly impact on Pakistan's agricultural growth rate.

H_4: The forest sector has significantly impact on Pakistan's agricultural growth rate.

H_5: The population growth has significantly impact on Pakistan's agricultural growth rate

Regression Diagnostics and Test of Significance

Regressions diagnostics are essential tools used to evaluate the quality of regression model with identify outliers, potential problems, and violations of assumptions (Gujarati, 2009; Islam, 2022; Schutzenmeister et al., 2012).

i. Normality in data: Normal Probability Plot (P-P Plots) and histogram with normal curve is applied to check, whether data or regression residual follow a normal distribution or not.

ii. Lower value of mean square error with higher value of coefficient of determination (R^2) indicates good fit.

iii. $MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$

$$R^2 = 1 - \frac{\sum(y_i - \hat{y}_i)^2}{\sum(y_i - \bar{y}_i)^2}, \quad R^2 = 1 - \frac{SSR}{SST}, \quad R^2_{Adjusted} = 1 - \frac{(1-R^2)(n-1)}{n-k-1}$$

iv. Where "y_i"= actual observations $\hat{y}_i$" = predicted observations “SSR” = sum of squared of regression “SST” total sum of squares, “n” no. of observations and “k” no. of predictors.

v. Multicollinearity: Variance Inflation Factor (VIF) is used to detect the multicollinearity. VIF>10 indicate multicollinearity.

$$\text{VIF} = \frac{1}{1-R^2}$$

vi. Homoscedasticity: Residuals versus fitted values plot is used to check Homoscedasticity

vii. Autocorrelation: Durbin-Watson (d) test is used to checks the autocorrelation in the residuals, d>2 indicate autocorrelation in the residual.

$$d = \frac{\sum_{t=2}^{t=n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{t=n}\hat{u}_t^2}$$

viii. Where "$\hat{u}_t$" = residual at period t and "$\hat{u}_{t-1}$" is residual of preceding period

ix. Constant variance: Plot of fitted values against residuals applied is used to detect the constant variance

x. P-value is used to check the statistical significance of overall model and regression coefficients of crops sector, livestock, fisheries, forestry and population. P- value> 0.05 indicate models and its coefficients are statistical significant.

Results and Discussions

Normality Analysis

The graphical presentation displayed both in figure 1 and figure 2, depicting P-P plots, and histograms overlaid with normal curves for agricultural growth rates, suggests that the present dataset follows to a normal distribution. There are no apparent abnormalities present in the response variable within the dataset.

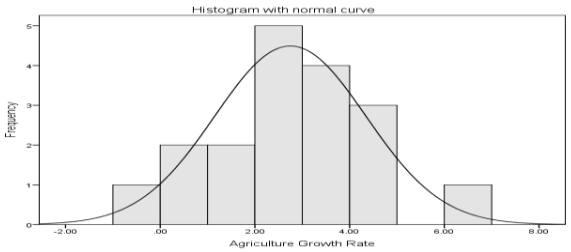

Figure 1: Histogram with Normal Curve for Cotton Productivity

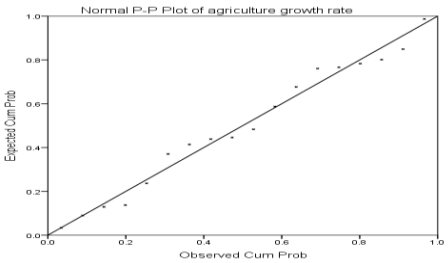

Figure 2: P-P Plot for Cotton Productivity

Descriptive Statistical Analysis

Table 1 shows the descriptive statistical analysis for the agricultural growth rates, and its sub sector i.e. crops sector, livestock, fisheries and forestry with population growth rates. On the average growth rates found 2.75% for agriculture sector, 1.27% for major crops, 4.12% for livestock, 4.48% for fisheries, -0.18% for forestry and 1.80% for Population. This shows that growth rise for all sectors except forestry. Comparing the absolute dispersion, found 1.60 for agriculture sector, 4.73 for major crops, 2.97 for livestock, 5.79 for fisheries, 5.23 for forestry 0.35 for population. This shows that growth in population and livestock is relatively consistent comparing with others. Raza et al. (2012) analyzed the data from 1980-2010 on GDP value added in PKR (in million) for agriculture sector, major crops and livestock. The study shifted from subsector growth rates of all sectors instead of monetary term by incorporating population growth rates. Usman (2016) conducted a study to analyze the contribution of the agriculture sector to GDP growth. He used data from 1990-2014 and found average growth rates of 5.10% for the agriculture sector, 4.85% for major crops, and 8.33% for livestock. In our current study, we extended the dataset to 2005-2023, included fisheries and forestry, and observed a decrease in average growth rates 2.75% for the agriculture sector, 1.27% for major crops, and 4.12% for livestock. Additionally, Usman (2016) reported absolute dispersions of 6.39, 9.36, and 10.78 for these sectors, which have decreased to 1.60, 4.73, and 2.97, respectively. These findings indicate a consistent decline in average growth rates and dispersions over the years.

Table 1: Descriptive Statistics for Growth Rats

Determinants	Agriculture	Major Crops	Livestock	Fisheries	Forestry	Population
Average growth Rate	2.75	1.27	4.12	4.48	-0.18	1.80
Std. Deviation	1.60	4.73	2.97	5.79	5.23	0.35

Regression Analysis

Table 2 shows the coefficients and significance of multiple linear regression. It is depicts here that a unit increase in major crops, livestock and fisheries will share to rise the agriculture growth rate about 0.316, 0.426 and 0.015, while decrease about -0.019 and -0.273 for forestry and population. The P-value found less than 0.05 for major crops, livestock and fisheries, and greater than 0.05 for forestry and population. It depicts that major crops, livestock and fisheries sectors have positively and significantly impacted on Pakistan's agricultural growth rate, while forestry and population have negatively and in-significantly impacted on Pakistan's agricultural growth rate. Regression model found statistically significant with good coefficient of determinations as 0.936 and MSE as 0.164. Model explained 93.6% variation and indicted a good fit. Model found free from autocorrelation as Durbin-Watson (d) test found less than 2.00. Figure 2 shows the P-P plots, histogram with normal curve and scatterplot for the error term. The p-p plots and histogram with normal curve for the error term, lead to fallows the normal distribution. The scatterplots of residuals vs. fitted values depicted that model free from heteroscedasticity. In contrast to Usman (2016), this study utilizes updated datasets, includes additional sub-sectors like fisheries and forestry, and incorporates population growth, offering a more comprehensive analysis of the agriculture sector. The some had been reported by Raza et al. (2012), that livestock had a significant contribution to agricultural growth, while fisheries and forestry had a minor role.Chandio et al. (2016) conducted a similar study, affirming the importance of major and minor crops and livestock in agricultural GDP, with forestry showing a positive but statistically insignificant impact. In our study, we found a negative impact of the forestry sector on agricultural GDP. Additionally, all necessary regression diagnostics are performed in our current study to elucidate the better fit of regression model.

Table 2: Coefficients and Significance Multiple Regression Analysis

Parameters	Intercept	Major Crops	Livestock	Fisheries	Forestry	Population
B	1.013	0.316	0.426	0.015	-0.019	-0.273
Sig.	0.091	0.00	0.00	0.613	0.414	0.403
VIF	--	1.242	2.618	2.81	1.456	1.267
Regression Models Determinants						
MSE = 0.164	R^2 = 0.936		F= 50.61	Sig = 0.00	D.W = 1.91	

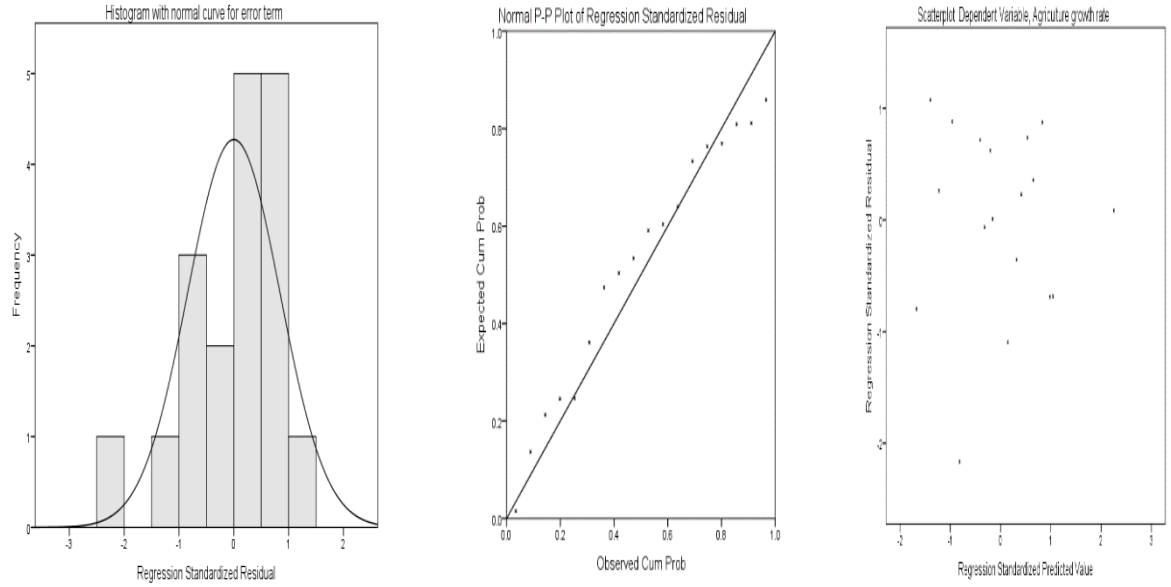

Figure 2: P-P Plots and Histogram with Normal Curve and Scatterplot for The Error Term

Conclusions

Agriculture sector holds immense significance in Pakistan, and playing a key role in providing food security, economic stability, and employment opportunities. However, despite its abundant natural resources and vast agricultural potential, Pakistan faces numerous challenges within its agriculture sector i,e. water scarcity, poor infrastructure, traditional farming, and financial struggles of farmers are hindering the sector's growth. The major subsectors of Pakistan's agriculture include crops, livestock, fisheries, and forestry, each making varying contributions to both the agriculture sector and the national economy. Pakistan's economic growth is threatened by its sub sector growth and impact of population growth in it. There is no remarkable research has been conducted in Pakistan which can take into account the statistical significance of specific agricultural sub-sectors like crops, livestock, fisheries, and forestry along with the population growth rate. The secondary dataset based on the growth rates of various sub sector of agricultural growth i.e. crops sector, livestock, fisheries, forestry along with population growth rates collected from Economic Survey of Pakistan for the year 2005 to 2023. Multiple regression are used to identify the statistical significance of determinates to agricultural growth. Descriptive statistics indicates that average growth rates found positive trends for agriculture, major crops, livestock, fisheries, and population. The absolute dispersion highlighted that population and livestock exhibited relatively consistent growth compared to other sectors. The regression model demonstrates a high goodness of fit, with a coefficient of determination R^2 of 0.936. Overall, the multiple linear regression models provides robust evidence that major crops, livestock, and fisheries significantly contribute to Pakistan's agricultural growth with respective coefficients of 0.316, 0.426, and 0.015, while forestry and population have negative and statistically insignificant impacts with coefficients of -0.019 and -0.273. This research is crucial to guide good policy decisions to and to boast agricultural growth in major sectors like crops, livestock, fisheries and forestry with special emphasis that how agriculture growth is being adversely affected by population growth rate.

Conflict of Interest: The authors declared no conflict of interest.

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