11

Explaining Agricultural Growth in Pakistan

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Abstract

Agriculture sector is the second-largest contributor to Pakistan's GDP, accounting for 24%. This research paper examines agricultural growth in Pakistan from 1990 to 2020. Using the Cobb Douglas production function (Capital and Labor) the paper determines the dominant factors influencing agricultural growth. Agricultural growth has shown consistent growth from 1990 to 2020. The study finds that agriculture credit, fertilizer usage, labor and water availability have a significant and positive impact on agricultural output. These findings are further reinforced by per hectare production analysis, which reveals that agriculture credit per hectare, fertilizer usage per hectare, labor per hectare and water availability per hectare have a positive and statistically significant relationship with agricultural output per hectare. When comparing these results to elasticities, the paper concludes that only agricultural credit and water appear to have a significant and positive relationship with agricultural output.

Introduction:

The agriculture sector is a cornerstone of development in many developing countries. It serves as a primary source of employment, especially in rural areas, providing livelihoods and food security for a significant portion of the population. Beyond its role in food production, the success and growth of the agriculture sector contribute significantly to the national economy. A thriving agricultural sector fuels economic development by driving growth in manufacturing and services sectors. Understanding the factors that drive agricultural growth is crucial, particularly for countries like Pakistan, which heavily rely on this sector. By analyzing these factors, policymakers and researchers can develop strategies to enhance agricultural

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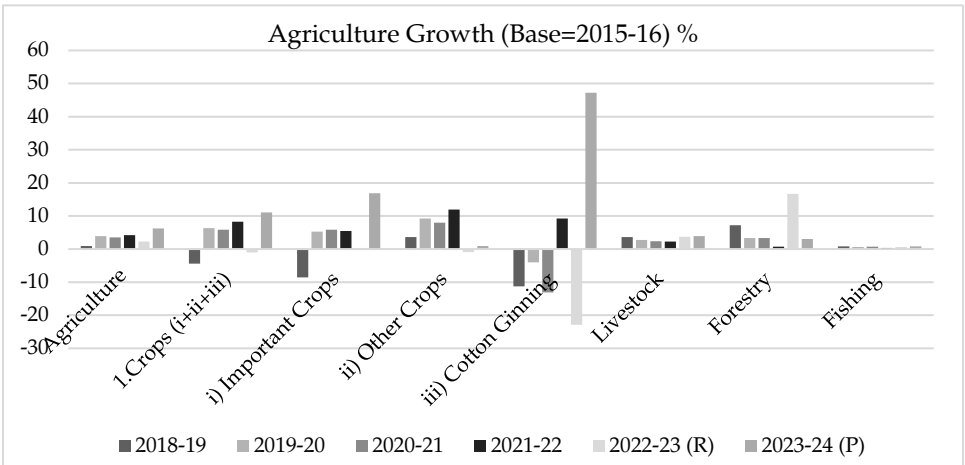
productivity, improve rural livelihoods, and contribute to overall economic development.

The significant role of agriculture in socio-economic development is evident in many countries. Early literature often focused on the passive linkage between agriculture and other sectors. For instance, Ranis and Fei (1961) posited that agriculture serves as a secondary factor in economic growth while the industrial sector is the primary driver of growth (Rosenstein-Rodan, 1943; Lewis, 1954). However, more recent perspectives, such as Subramaniam and Reed, (2009) emphasize the critical role of agriculture in rural populations' food security, livelihoods, and employment. Agriculture directly impacts the national economy and positively influences other sectors, improving the lives of many. By providing employment, reducing poverty and enhancing standards of living, agriculture fosters economic growth and development. Its linkages with other sectors further solidify its importance, as it supplies raw materials to industries, generates demand for industrial products, and contributes to urban development.

Pakistan, being an agrarian economy, derives a significant portion of its economic growth from agriculture. According to Punjab Bureau of Statistics (2023-24), this sector contributes 24% to the country's GDP, making it the largest sector of the economy. It provides direct and indirect employment to 37.4 million people. The Economic Survey (2023-24) further highlights the sector's importance, stating that it sustains the livelihoods of 68% of the population. With a population of 241.5 million in 2023, with 147.75 million people reside in rural areas, heavily reliant on agriculture. The Punjab Bureau of Statistics (2023) estimates that agriculture directly or indirectly contributes to 70% of export earnings (Pakistan Economic Survey 2023-24).

In the last fiscal year, Pakistan's agriculture sector productivity increased from 2.27% to 6.25%. Pakistan is the fourth-largest cultivator and supplier of rice, wheat, and cotton. Rice is one of the country's primary export crops (Pakistan Economic Survey 2023-24).

Figure 1: Agriculture Sector Performance



Source: Pakistan Economic Survey 2022-23

Despite the recent increase in agricultural productivity, Pakistan's agricultural sector has faced challenges in previous years, leading to a slowdown in overall growth This slowdown can be attributed to poor total factor productivity, meaning that the output is not increasing proportionally to the inputs used. As Ahmad et.al (2013) pointed out, numerous challenges are impacting the sector's productivity and sustainability. Several factors contribute to these challenges including, water scarcity due to growing population, (Kahlown & Majeed, 2003), rise in inflation, load shedding, high diesel prices, lack of crop insurance, inadequate post-harvest technologies and poor agricultural policies (Pakistan Economic Survey 2023-24; Sadaf et al., 2005; Shah & Farooq, 2000).

This paper aims to identify the key factors that driving real agricultural growth in Pakistan through time series analysis. Specifically, the paper seeks to determine the relative contributions of land, labour, and capital to agricultural growth. The paper is structured as follows: Section 2 reviews existing literature, Section 3 details the data, model and methodology. Section 4 presents the results, and Section 5 concludes with a discussion of the findings.

Literature Review

A substantial body of literature has explored the importance of agriculture and the factors driving its growth. Baig et al., (2016) argue that labor is a primary factor influencing agricultural growth. Increasing the labour force employed in agriculture can significantly enhance output, particularly when applied to a fixed land area, leading to improved labor productivity. Agricultural output is frequently measured

through total factor productivity (TFP). Human Capital significantly impacts TFP growth in Pakistan's agriculture sector. Literature suggests that human capital has the highest impact on agriculture in Pakistan, with an elasticity coefficient of 0.54, (Sabir & Ahmed 2008). According to Kemal et.al (2002), technical change and efficiency play a crucial role in radically enhancing labour productivity. Their study revealed that compared to neighbouring countries (India, Bangladesh, Sri Lanka, Malaysia and Korea), Pakistan's lower investment in technological development hindered labour productivity and consequently, agricultural growth. Similar results were found by Hamid and Ahmad (2009) who used data from 1972-1973 to 2006-2007 for Pakistan. Employing the Cobb-Douglas production function, their research explored the variations in agricultural value added. The study concluded that labor employed in agriculture, along with capital stock, has a positive and significant impact on value added in agriculture.

The availability of agricultural land is a perquisite for agricultural production. The area under cultivation, along with the amount fertilizer used, positively impacts agricultural output. Awan and Mustafa (2013) found a positive and significant relationship between agricultural output and cropped area. However, Ahmad and Heng (2012) suggest that cropped area alone is not a significant determinant of agricultural productivity; rather, the combination of cropped area and fertilizer usage contributes to increased productivity in Pakistan. Hamid and Ahmad (2009) further emphasize the importance of intermediary inputs, technology, and human resources in agricultural value addition. Intermediate inputs such as fertilizers, high yielding seeds, and pesticides play a crucial role in improving agricultural productivity (Chandio et al., 2016; Ahmed et al., 2015; Awan & Mustafa, 2013; Waqar et al., 2008; Iqbal et al., 2003; Sohail et al., 1991 & Zuberi, 1990) Further research by Sabir and Ahmed (2003) in Pakistan found that fertilizer subsidies, when implemented effectively to ensure better quality and availability of fertilizers, have a negligible negative impact on total factor productivity. In other words, such subsidies can be beneficial. Additionally, Ali and Iqbal (2005) point out that the use of modern machinery, coupled with pesticides, fertilizers and high-yielding seed varieties, contribute significantly to the value-added growth in Pakistan's agriculture and overall GDP growth. However, this advancement in agricultural technology may come at a cost. Abbas et al. (2005) highlight a potential decline in labor absorptive capacity, particularly for those with basic education or lacking formal education. The implication is that while modern inputs can boost agricultural output and economic growth, policymakers need to consider potential consequences for employment, particularly among less-educated segments of the rural population.

Water availability is another critical factor of production in agriculture. Historically a water-surplus country, Pakistan now faces severe water scarcity. Khan et al. (2013) identify water scarcity as a major threat to agriculture productivity. The

Indus River, supplying 90% of Pakistan's agricultural agriculture, is becoming increasingly unreliable due to a growing population projected to reach 250 million by 2025. Kahlown and Majeed (2003) confirm that Pakistan's water resources are under immense pressure.

However, there are glimmers of hope. The Asian Development Bank (2023) recently approved a $180 million loan to improve Pakistan's water and waste management system, aiming to increase water availability in the coming years. Rehman et.al (2019) found has negative and significant impact of water availability on agricultural GDP, highlighting the importance of water resource management for sustained agricultural growth.

Awan and Mustafa (2013) found a positive and significant relationship between water availability and agricultural output, indicating that increased water availability can positively impact agricultural productivity. This finding aligns with numerous other studies that highlight the importance of water for agriculture. Chandio et al. (2016), Ahmed et al. (2015), Waqar et al. (2008), Iqbal et al. (2003), Sohail et al. (1991) and Zuberi (1990) have all shown that water has a significant and positive impact on agricultural output.

Access to credit and information is crucial for agricultural growth. Hayat et al. (2019) highlight the dual role of credit, both financial and informational, in enhancing agricultural productivity. Financial credit enables farmers to purchase essential inputs like fertilizers and machinery, while informational credit empowers them with knowledge about advanced farming techniques. Given the significant role of agriculture in providing livelihoods, employment and poverty reduction (Abbas et al., 2005) access to credit is crucial. The study demonstrates the positive impact of micro credit on income generation and poverty reduction. The impact of credit can vary based on farm size. Anriquez and Valdes (2006) found that both formal and informal credit are positively correlated with land ownership. However, for small farmers, the impact of credit on agricultural productivity was negative and statistically significant; potentially due to over-borrowing. Parikh and Shah (1994), emphasize the importance of credit per hectare, highlighting its significant and positive impact on agricultural output efficiency. The study reveals that young farmers with access to micro credit, larger assets, proximity to markets, and better education and technology perform more efficiently. Rehman et.al (2019) stress the combined impact of credit disbursement, fertilizer usage, and improved seed on agriculture growth rates. This underscores the importance of a multi-pronged approach to agricultural development.

In the past few years, risingfood prices have pushed a significant number of people below the poverty line. As agriculture plays a crucial role in in poverty alleviation, commodity prices significantly influence the sector. Ahmad and Heng (2012) argue that lower prices and higher agriculture output are essential for

economic growth. However, Awan & Mustafa (2013) highlight that increased prices can mitigate the impact of increased agricultural output. The affordability of improved seeds can boost crop production, which can then be sold at higher prices. Therefore, a combination of lower input prices and higher selling prices can contribute to increased agricultural productivity.

Methodology

The paper aims to examine and explain the basic factors that influence agricultural output using the Cobb-Douglas production function. The factors considered include land, labour and capital. Land is represented by the cropped area in millions, and capital by agricultural credit and fertilizer usage. Labour is labour force employed in agriculture sector in millions. Agricultural credit is measured in million rupees, while fertilizer usage is measured in thousand nutrient tonnes and then converted to million rupees. The price variable represents the procurement price of wheat in rupees per 40 kg. Secondary data from the Pakistan Economic Survey 2023-24 was used for the period 1990-2020. The availability and recording of data in the Economic Survey constrained the study's timeframe.

Cobb-Douglas production function

$$\mathrm{Y} = \mathrm{F}(\mathrm{A}, \mathrm{K}, \mathrm{L})$$

$$\mathrm{Y} = \mathrm{F}(\mathrm{K}, \mathrm{L}, \ \mathrm{H_2O})$$

$$\mathrm{Y} = \mathrm{F}(\mathrm{Credit}, \mathrm{Fertilzer}, \mathrm{Labour}, \ \mathrm{H_2O})$$

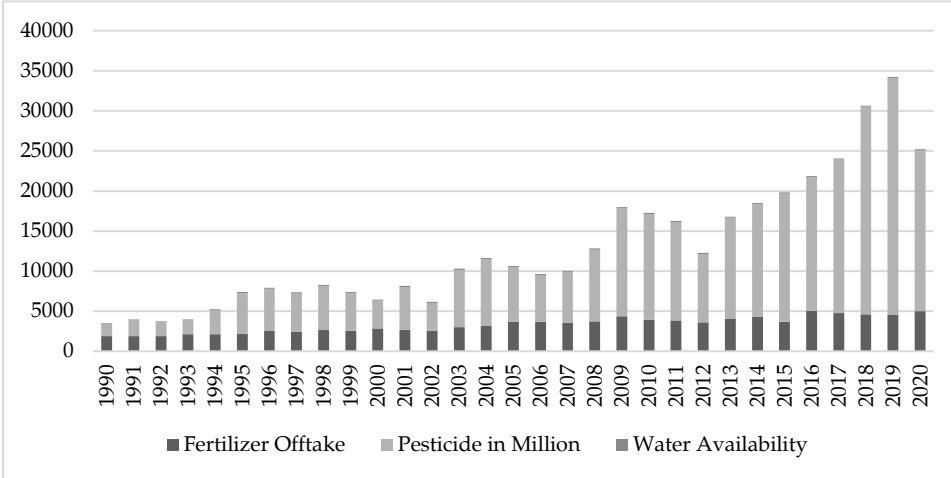
Econometric Model:

$$\mathrm{AgricultureOutput} = \beta_0 + \beta_1 \mathrm{AgricultureCredit}_t + \beta_2 \mathrm{CroppedArea}_t + \beta_3 \mathrm{FertilizerOfftake}_t + \beta_4 \mathrm{Labour}_t + \beta_5 \mathrm{Pesticide}_t + \beta_6 \ \mathrm{Water\ Availability}_t + \beta_7 \ \mathrm{Price}_t + \varepsilon_t$$

Graphical Representation

Figure 2 illustrates the intermediate input contributions of fertilizer, pesticide and water. It is evident that pesticide usage has been consistently increasing, followed by fertilizer usage in Pakistan. In contrast, water usage has not shown a significant increase, aligning with the literature that suggests water availability is a constraint.

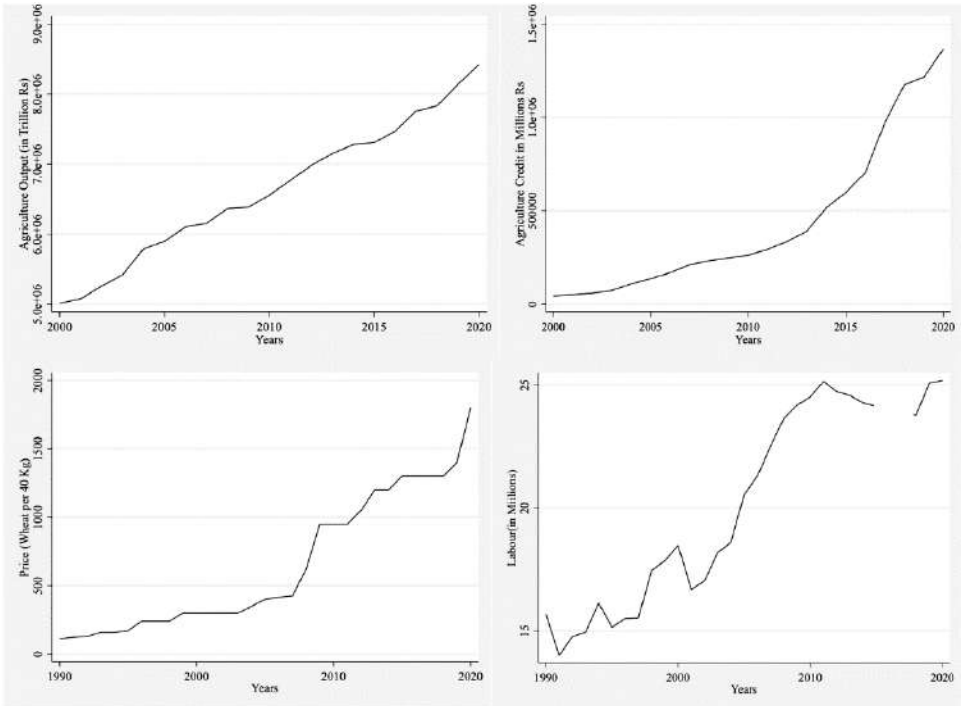
Figure 2: Intermediate Contribution



Source: (Pakistan Economic Survey 2022-23).

Figure 3 illustrates the time trends of various variables. The data shows an increasing trend in agricultural output over the years. Similarly, agricultural credit has also increased, indicating a rise in credit disbursement to farmers, which can improve their financial position. The price of wheat has also been gradually increasing. Regarding labor force participation, the trend shows an upward trajectory. This could be attributed to either a growing population or the agriculture sector's capacity to absorb a larger labor force, especially in rural areas where agriculture often provides the primary employment opportunity.

Figure 3: Time Trends



Source: (Pakistan Economic Survey 2022-23).

Results

This section discusses the econometric results. Table 1 presents the results of a simple time series OLS regression. The first regression shows that agriculture credit, fertilizer offtake, labor, and water availability have a significant and positive impact on Pakistan agricultural output. As the literature suggests, the combination of input factors and is crucial for productivity, and the results indicate that cropped area has a significant but negative impact on growth. Additionally, price negatively affects output. In regressions 2 and 3, the paper removes cropped area, price and pesticides from the analysis. The results consistently show that agricultural credit, fertilizer offtake, labor and water availability remain significant and positively associated with agricultural output. The R-squaresd values of all models are above 0.9, indicating a high degree of model fit.

Table 1: Dependent Variable - Agriculture Output in Millions

VARIABLES	OLS1	OLS2	OLS3	OLS4
AgricultureCredit	0.917**	0.857***	0.564**	0.309**
	(0.327)	(0.249)	(0.259)	(0.242)
CroppedArea	-215,275**	-214,362**		
	(91,854)	(88,657)		
FertilizerOfftake	621.6**	604.7***	429.8**	455.5**
	(218.8)	(205.1)	(175.8)	(180.3)
Labour	85,319**	85,136**	68,388*	57,476*
	(33,746)	(32,795)	(36,588)	(31,869)
Pesticide	-5.180			
	(12.13)			
WaterAvailability	37,287**	37,763***	37,772**	35,656**
	(13,370)	(13,106)	(14,034)	(14,648)
Price	-925.9***	-921.8***	-473.0*	
	(305.6)	(283.7)	(233.5)	
Constant	-2.010e+06	-2.068e+06	-6.238e+06***	-5.608e+06***
	(1.900e+06)	(1.824e+06)	(1.543e+06)	(1.556e+06)
Observations	28	28	28	28
R-squared	0.933	0.933	0.916	0.910

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Table 2 the presents the growth rates of various variables over the period. Agriculture has shown a remarkable growth rate of 9.91% for over three decades, indicating consistent and stable growth in the sector. This is a positive sign for Pakistan, an agro-based economy, as it suggests future prosperity. This consistent growth in agriculture can be associated with credit disbursement by the government, which has grown at a rate of 17.5%. In contrast, water availability has shown a very slow growth rate of only 0.3%, potentially limiting agricultural growth. The price of wheat has been growing at a rate of 10.5%, which is higher than the growth rate of agriculture. This could contribute to the negative impact of price on agricultural output, as discussed earlier. Interestingly, labor participation in agriculture has shown negative growth, suggesting that over the past three decades, labor may have found alternative employment opportunities outside the agricultural sector.

Table 2: Descriptives - Growth

Variable	Obs	Mean	Std. Dev.	Min	Max
AgriGrowth	30	9.91	19.54	-.721	106.18
ACRGrowth	30	17.563	17.026	-13.034	68.967
CAGrowth	30	.377	2.399	-4.818	5.009
RainfallGrowth	30	5.303	34.595	-33.425	89.947
FertGrowth	30	3.778	10.371	-14.289	36.245
PetrolGrowth	30	-6.725	23.089	-61.022	46.855
ElectGrowth	30	2.371	8.347	-19.217	13.871
LabourGrowth	27	-1.725	20.304	-100	12.5
PestGrowth	30	13.726	34.371	-35.328	107.99
WAGrowth	30	.333	1.833	-4.703	2.654
PriceGrowth	30	10.535	14.636	0	52

Source: Authors calculations

Table 3 presents the elasticities from the OLS model. Across all four regressions agriculture credit shows a positive and significant elasticity. A 1% increase in agriculture credit leads to a 0.3% increase in the agricultural output. Similarly, water availability exhibits a significant and positive elasticity. A 1% increase in water availability leads to more than an 8% increase in the agricultural output, a consistent finding across all calculations. In contrast, the remaining variables, including cropped area, fertilizer, labour, pesticides and price, were found to be insignificant for Pakistan.

Table 3: Dependent Variable: Natural Log of Agriculture Output

VARIABLES	OLS1	OLS2	OLS3	OLS4
LnAgricultureCredit	0.395**	0.387**	0.392**	0.320*
	(0.176)	(0.176)	(0.176)	(0.172)
LnCroppedArea	-1.592	-1.651		
	(2.216)	(2.081)		
LnFertilizerOfftake	1.452	1.326	1.009	0.907
	(0.852)	(0.788)	(0.733)	(0.716)
LnLabour	-0.759	-0.588	-0.570	-0.790
	(1.089)	(0.829)	(0.811)	(0.731)
LnPesticide	-0.0746			
	(0.223)			
LnWaterAvailability	8.292***	8.305***	8.582***	8.469***
	(1.648)	(1.647)	(1.755)	(1.736)
LnPrice	-0.220	-0.268	-0.222	
	(0.284)	(0.192)	(0.201)	
Constant	-33.63***	-33.29***	-37.64***	-36.12***
	(6.495)	(5.830)	(5.392)	(5.430)

VARIABLES	OLS1	OLS2	OLS3	OLS4
Observations	28	28	28	28
R-squared	0.928	0.927	0.925	0.923

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

to further strengthen the research findings, the paper conducts a per-hectare analysis, with results presented in Table 4. This analysis reveals a significant and positive impact of credit per hectare on output per hectare. Similarly, fertilizer and water per hectare also exhibit a significant and positive relationship with output per hectare. Additionally, labor per hectare is found to positively influence per-hectare productivity. These findings from the per-hectare analysis corroborate the results obtained from the simple OLS regression.

Table 4: Dependent Variable: Agriculture Output Per Hectare

VARIABLES	OLS1	OLS2	OLS3
ACRperHectare	0.852**	0.755***	0.611**
	(0.343)	(0.261)	(0.273)
FertperHectare	778.1***	756.1***	752.1***
	(181.7)	(168.2)	(151.7)
LabourperHectare	72,043**	71,767**	66,041*
	(34,253)	(33,689)	(32,456)
PestperHectare	-7.870		
	(14.01)		
WaterperHectare	27,208**	27,533**	25,966**
	(12,816)	(12,670)	(13,182)
Price	-40.71***	-40.49***	
	(13.53)	(12.63)	
Constant	-253,215***	-253,797***	-193,325**
	(66,413)	(65,397)	(71,566)
Observations	28	28	28
R-squared	0.923	0.923	0.906

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Discussion and Conclusion:

The findings of the paper align with existing literature on the factors influencing agricultural output. Agricultural credit, fertilizer usage, and water availability emerge as key drivers of agricultural growth in Pakistan. The positive impact of agricultural credit on output is consistent with Parikh and Shah (1994) and Hayat et al. (2019), who emphasize the crucial role of financial resources in boosting agricultural productivity. The positive correlation between fertilizer usage and agricultural output is further supported by studies like Chandio et al. (2016), Ahmed

et al. (2015), Awan & Mustafa (2013), Waqar et al. (2008), Iqbal et al. (2003), Sohail et al. (1991), and Zuberi (1990).

This paper further supports existing literature regarding the positive and significant impact of labour and water on agriculture. Labor is considered a primary factor influencing agricultural output, especially in developing countries (Kakar, Kiani & Baig, 2016). Similarly, Hamid and Ahmad (2009) found that labor and capital stock positively impact agricultural value-added. Awan and Mustafa (2013) also observed a positive and significant relationship between water availability and agricultural output.

The study demonstrates that agricultural credit, labor, water availability, and fertilizer significant contributors to agricultural growth in Pakistan. These variables effectively explain the observed upward trend in agricultural output.

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