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Unraveling Pakistan's Agricultural Tapestry: Dynamics of Major Crop Production and Economic Implications

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This study presents a comprehensive analysis of major crop dynamics in Pakistan, focusing on cotton, sugarcane, rice, maize, and wheat, utilizing data from the Pakistan Bureau of Statistics. Despite the significant contributions of the agricultural sector to Pakistan's economy, challenges such as population growth, decreasing per capita land availability, and fluctuations in crop production pose threats to sustainability. Through descriptive statistics and regression analysis, the study explores the relationships between crop production, GDP contribution, and agricultural value added. Cotton, sugarcane, rice, maize, and wheat collectively contribute to economic growth and food security, but their correlations with agricultural gain vary. While cotton and sugarcane exhibit low correlations, rice shows an inverse relationship, maize demonstrates a strong positive correlation, and wheat displays an insignificant correlation with agricultural gain. These findings underscore the complexity of Pakistan's agricultural landscape, emphasizing the need for multifaceted strategies to enhance productivity, profitability, and sustainability in the sector.

Keywords: Threats To Sustainability, Food Security, Crop Production, GDP Contribution.

Introduction:

Pakistan, an agrarian nation, relies heavily on its agricultural sector, which utilizes 22 million hectares of the total land area of 80 million hectares for production. Over the last three decades, there has been a notable increase in cropping area, rising from 16.62 million hectares to 22.15 million hectares between 1971 and 2003 [1]. However, this expansion has been outpaced by the rapid population growth, leading to a significant decrease in per capita land availability. Projections indicate a worrisome outlook for the agricultural economy due to the projected annual growth rate [2]. The economy of Pakistan heavily depends on the agricultural sector, which contributes 21% to the Gross Domestic Product (GDP) and employs over 48.4% of the total workforce [3]. With the cropping sector alone contributing 60% to the GDP, while livestock and forestry contribute the remaining 40%, agriculture remains the backbone of the country's economy according to the Government of Pakistan (2011). Despite its crucial role, the agricultural sector in Pakistan faces serious challenges that need urgent attention and resolution to ensure its sustainability and contribution to the overall economy [4] [5].

As per the United Nations Millennium Declaration, addressing extreme hunger and poverty is a critical component of the Millennium Development Goals (MDGs), underscoring the global importance of food security in today's world [6]. The world population is projected to reach approximately 9.3 billion by 2050, and a significant increase is anticipated in Pakistan's population in the coming decades, currently standing at 19.1 million in 2015 and is expected to reach 242.06 million by 2030 and 300 million by 2050 according to the Pakistan Bureau of Statistics (PBS) for 2014-15, the need for adequate food, clothing, shelter, and other essentials is paramount [7]. The burgeoning population places strain on economic resources and

underscores the reliance of the younger generation on the country's economy [8]. Agriculture plays a pivotal role in providing sustenance and employment to the populace, with major crops forming the backbone of the nation's food supply. Given the direct correlation between population growth and food demands, it becomes imperative to focus on enhancing agricultural productivity [6] [9].

Moreover, agriculture not only serves as a primary source of employment but also supplies raw materials to export-oriented industries in Pakistan [10] [11]. The agriculture sector contributes significantly to the Gross Domestic Product (GDP), accounting for 20.9%, and employs approximately 43.5% of the rural population [4]. While official statistics indicate a growth rate increase in the agriculture sector from 2.7% in 2013-14 to 2.9% in 2014-15, a concerning trend emerges as the production of major food crops experiences negative growth during the same period according to PBS for 2014-15 [12].

Key crops such as wheat, rice, cotton, maize, and sugarcane collectively contribute 25.6% of value added in the overall agriculture sector and 5.3% to GDP in Pakistan [13]. Wheat, a major crop by cultivation area, contributes 10% of value added in agriculture and 2.1% of GDP, yet a decrease in both cultivation area and production is observed [14]. Similarly, rice, accounting for 0.7% of GDP and 3.2% of agriculture value added, records an increase in both cropped area and production during the fiscal year 2014-15 [15]. Conversely, maize, a prominent food crop constituting 0.4% of GDP and 2.1% of agriculture value added, witnessed a decline in both cropped area and production during the same period as per PBS for 2014-15 [16].

Cotton, crucial for foreign exchange earnings through exports and supplying raw materials to the textile industry, contributes 1.5% of GDP and 7.1% of value added in agriculture [16]. Despite an increase in both cropped area and production, sugarcane considered a cash crop, experienced a decrease in both cropped area and production during the same period [17]. These observations, as reported by PBS for 2014-15, underscore the intricate dynamics of Pakistan's agricultural sector and highlight the imperative need for strategic interventions to bolster productivity and sustainability amidst growing population pressures [18].

Objective:

The objective of this study is to comprehensively analyze the trends and relationships among major crops in Pakistan, focusing on cotton, sugarcane, rice, maize, and wheat, utilizing agricultural data sourced from the Pakistan Bureau of Statistics. The study seeks to delve into various aspects of each crop, including cultivation trends, and production levels. Furthermore, the research aims to explore the correlation between crop production and agricultural gain, aiming to identify the factors that influence agricultural outcomes in Pakistan's agricultural sector. By providing insights into the complexities of Pakistan's agricultural landscape, such as its contributions to the economy, food security, and employment generation, the study intends to offer valuable recommendations for policymakers and agricultural stakeholders to enhance agricultural productivity, profitability, and sustainability across the country.

Methodology:

Data Collection:

The data regarding the cultivation area, production levels, and contributions to GDP and agriculture value added for five major crops in Pakistan (cotton, sugarcane, rice, maize, and wheat) were collected from the Pakistan Bureau of Statistics.

Data Preparation:

The collected data were organized into a suitable format for analysis in SPSS software. This involved formatting the data into a structured dataset with relevant variables such as crop type, cultivation area, production levels, and contributions to GDP and agriculture value added [19].

Descriptive Statistics:

Descriptive statistics were performed on the dataset using SPSS to summarize the characteristics of the data. This included calculating measures such as means, standard deviations, and frequencies to describe the central tendency, variability, and distribution of the variables.

Regression Analysis:

Regression analysis was conducted using SPSS to explore the relationships between different variables, specifically focusing on the relationship between crop production and contributions to GDP and agriculture value added. Simple linear regression models were employed to assess the strength and direction of these relationships.

Interpretation of Results:

The results obtained from the descriptive statistics and regression analysis were interpreted to draw meaningful conclusions about the agricultural trends and relationships observed in the data. This involved examining patterns, trends, and correlations to understand the dynamics of crop production and its economic implications.

Visualization:

Graphs and figures were generated using SPSS to visually represent the data and analysis results, aiding in the interpretation and communication of findings.

Results and Discussion:

Cotton, sugarcane, rice, maize, and wheat collectively form the backbone of Pakistan's agricultural sector, contributing significantly to the country's economy, food security, and employment generation. Cotton, known as the "white gold" of Pakistan, has been a crucial crop since the country's inception. Pakistan ranks among the top cotton-producing countries globally. The textile industry, which relies heavily on cotton as its primary raw material, accounts for a significant portion of Pakistan's GDP and export earnings. Additionally, cotton cultivation provides employment to millions of farmers and laborers, particularly in the fertile plains of Punjab and Sindh. Figure 1 shows the area, Production, and yield of the cotton crop. Cotton cultivation area has fluctuated, decreasing from 2018 to 2020, with a slight increase in 2021 and a subsequent decrease in 2022. Production of cotton peaked in 2018 and reached its lowest point in 2020, with a significant drop from 2019 to 2020. The yield of cotton per hectare varied, with the highest yield in 2021 and the lowest in 2022.

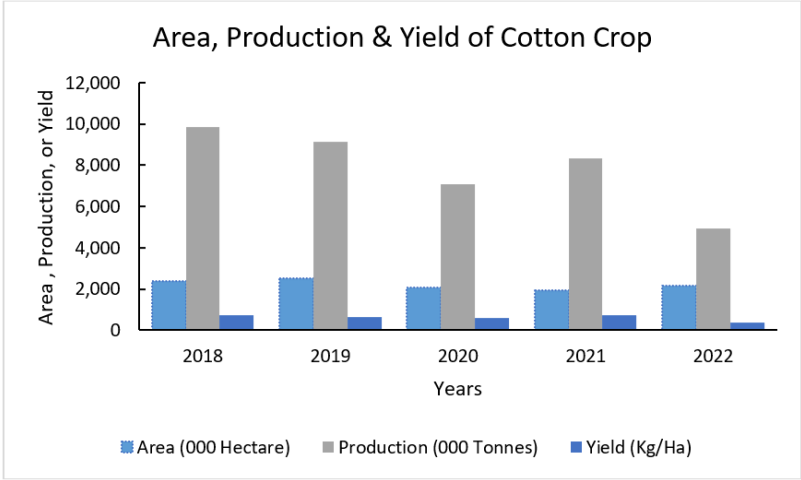

Figure 1: Area, Production & Yield of Cotton Crop.

The figure 2 represents the relationship between the production of cotton (measured in thousand tonnes) and the agricultural gain (measured in percentage) over the years 2018 to 2022. With an R^2 value of 0.6605, the graph indicates a positive and direct correlation between cotton production and agricultural gain. Upon examination of the data points, we observe some

fluctuations in both cotton production and agricultural gain over the years. In 2018, cotton production was at its highest, reaching 9,861 thousand tonnes, with a corresponding agricultural gain of 19.53%. However, in the following years, both production and agricultural gain experienced a decrease, reaching their lowest points in 2020, with cotton production dropping to 7,064 thousand tonnes and agricultural gain decreasing to 15.66%.

Interestingly, despite a slight increase in cotton production in 2021 to 8,329 thousand tonnes, the agricultural gain continued to decrease, dropping to 11.26%. In 2022, there was a significant decrease in cotton production to 4,910 thousand tonnes, but the agricultural gain experienced a slight increase to 12.79%. Overall, while there is a moderate positive correlation between cotton production and agricultural gain, the fluctuations observed suggest that other factors besides production may influence agricultural gain. Further analysis would be needed to identify and understand these factors contributing to the variability in agricultural gain despite changes in cotton production.

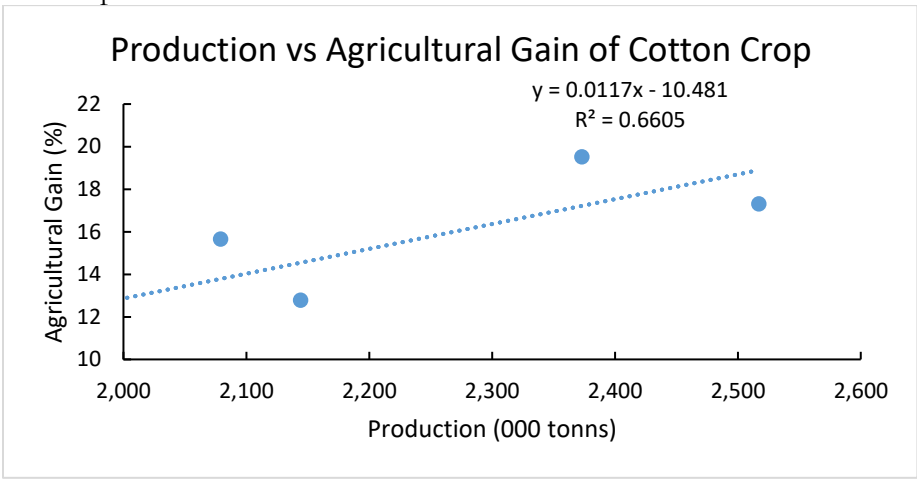

Figure 2: Comparison of Production and Agricultural Gain of Cotton Crop.

Sugarcane is another vital cash crop in Pakistan, primarily cultivated in Punjab and Sindh provinces. The sugar industry is a major player in Pakistan's agro-based economy, contributing substantially to GDP and providing raw materials for various downstream industries such as confectionery and beverages. Sugarcane cultivation not only generates income for farmers but also creates employment opportunities during harvesting and processing seasons. The area under sugarcane cultivation showed minor fluctuations, peaking in 2021. Sugarcane production increased steadily over the years, reaching its highest level in 2022. Yield per hectare of sugarcane exhibited minor variations, with the highest yield in 2021. Figure 3 shows the area, production, and yield of sugarcane crops in Pakistan.

The graph illustrates the relationship between the production of sugarcane (measured in thousands of tonnes) and the corresponding agricultural gain (expressed as a percentage) over a five-year period from 2018 to 2022. The data points reveal a somewhat scattered distribution, indicating variability in the relationship between sugarcane production and agricultural gain during this time frame. With an R^2 value of 0.0747, the graph suggests an inverse correlation between sugarcane production and agricultural gain. This means that only approximately 7.47% of the variability in agricultural gain can be explained by changes in sugarcane production. In other words, while there may be some association between the two variables, it is not strong enough to reliably predict agricultural gain solely based on sugarcane production. Despite the lack of a strong correlation, there seems to be a general trend of increasing agricultural gain with higher sugarcane production, particularly evident in the years 2021 and 2022. However, this trend is not consistent across all years, as seen by the variability in agricultural gain despite changes in production levels.

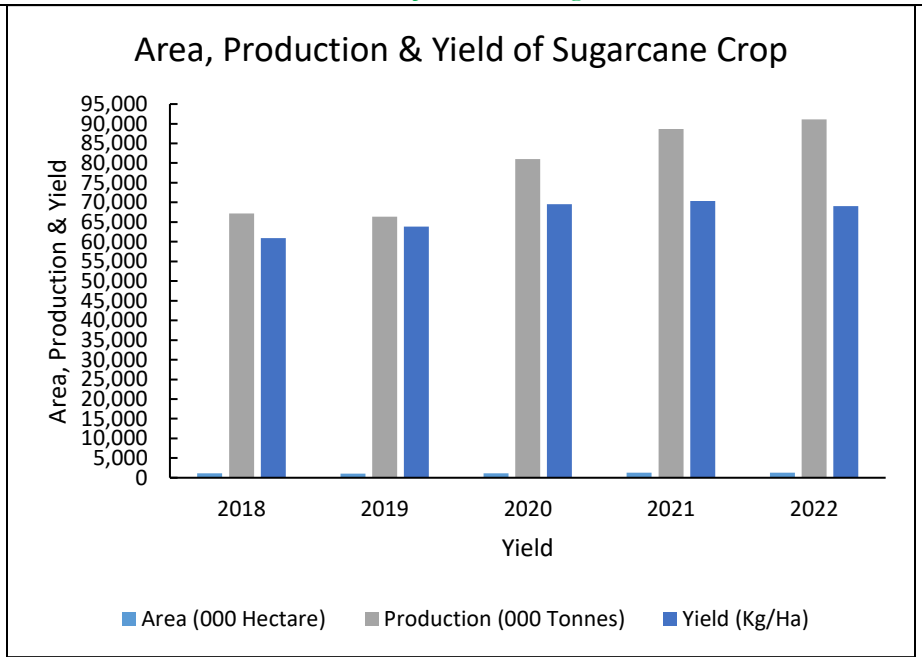

Figure 3: Area, Production & Yield of Sugarcane Crop.

Overall, while sugarcane production may have some influence on agricultural gain, other factors such as market demand, weather conditions, and agricultural practices likely play significant roles in determining the actual agricultural gain percentage. Therefore, further analysis and consideration of these factors are necessary for a comprehensive understanding of the dynamics affecting sugarcane cultivation and its associated agricultural gain.

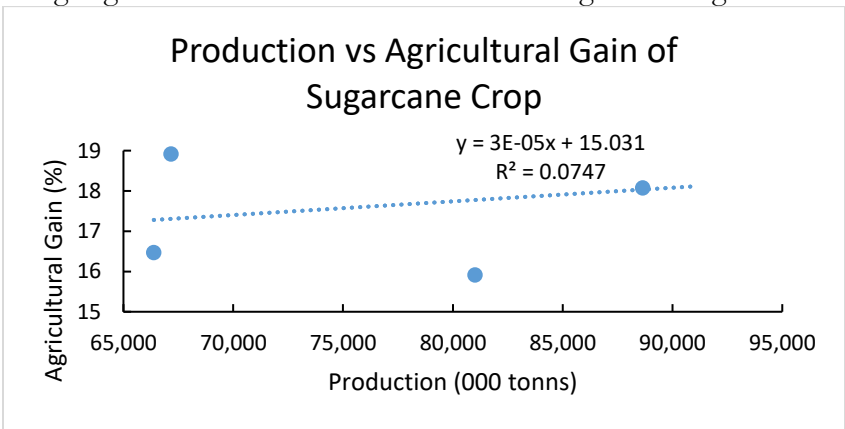

Figure 4: Comparison of Production and Agricultural Gain of Sugarcane Crop.

Rice is a staple food crop in Pakistan, with the country being one of the largest rice exporters globally. Rice cultivation supports the livelihoods of millions of farmers, particularly in Punjab and Sindh. Apart from its importance in ensuring food security, rice also contributes significantly to foreign exchange earnings through exports. Figure 5 illustrates the area, production, and yield of rice crops. The rice cultivation area increased steadily until 2021, with a slight decrease in 2022. Rice production followed a similar trend, rising steadily until 2021, with a slight decline in 2022. The yield of rice per hectare remained relatively stable over the years, with minor fluctuations.

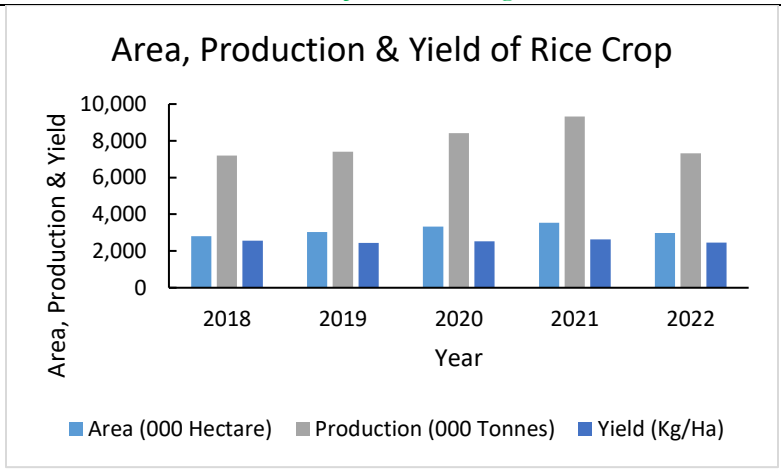

Figure 5: Area, Production, and Yield of Rice Crop.

The graph depicting the relationship between rice production and agricultural gain reveals an interesting insight despite the relatively low R-squared value of 0.1549, indicating a negative correlation. Despite the negative correlation, we can observe a trend of decreasing agricultural gain as rice production increases. This inverse relationship suggests that as rice production increases, the agricultural gain percentage tends to decrease. While the weak correlation suggests that other factors may also influence agricultural gain, understanding this inverse relationship between rice production and agricultural gain is crucial for policymakers and agricultural stakeholders to make informed decisions regarding crop management practices, resource allocation, and agricultural policies aimed at maximizing both production and agricultural gains in the rice sector.

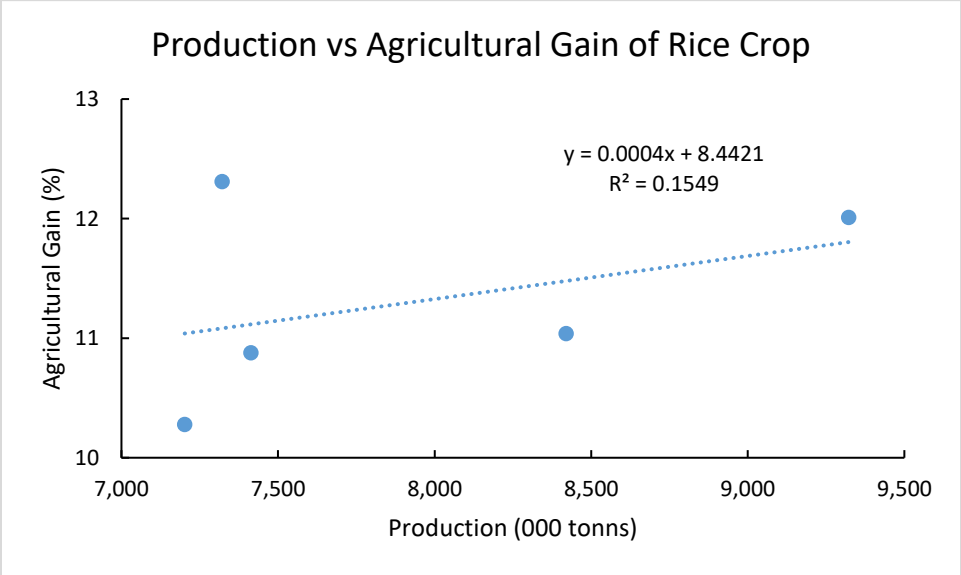

Figure 6: Comparison of Production and Agricultural Gain of Rice Crop.

Maize cultivation is prevalent across various agro-climatic zones in Pakistan. It serves as a staple food for both humans and livestock, contributing to food security and animal husbandry. Maize also plays a crucial role in diversifying cropping patterns and enhancing agricultural productivity, particularly in areas where water availability is limited. Figure 7 shows the area, production, and yield of maize crops. The maize cultivation area showed a slight increase over the years, reaching its peak in 2022. Maize production increased steadily from 2018 to 2022. Yield per hectare of maize remained relatively stable, with minor fluctuations.

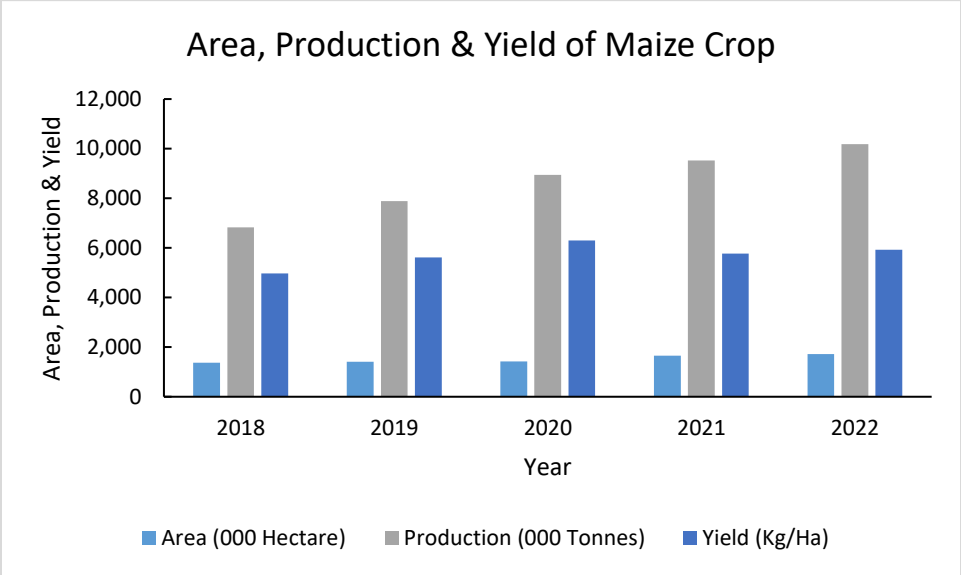

Figure 7: Area, Production & Yield of Maize Crop.

With an R^2 value of 0.9657, which indicates a strong positive correlation between production and agricultural gain, the graph demonstrates a clear relationship between the two variables for the maize crop. As production (measured in thousands of tonnes) increases, agricultural gain (measured as a percentage) also increases consistently. This positive correlation suggests that higher production levels of maize result in a greater agricultural gain percentage. Therefore, as farmers increase their maize production, they can expect to achieve higher agricultural gains in terms of percentage return. This relationship is crucial for decision-making processes related to maize cultivation, as it highlights the potential for increased agricultural profitability with higher production levels.

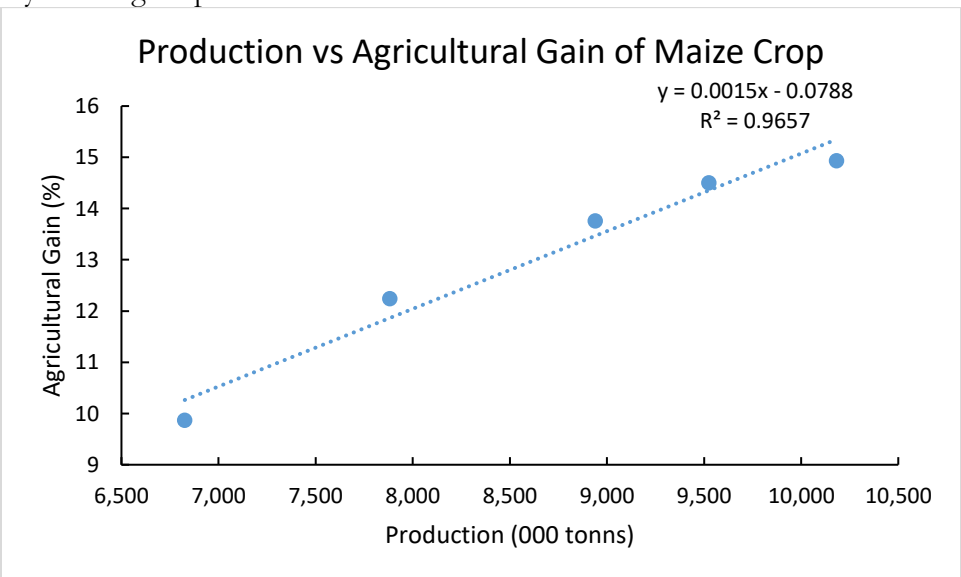

Figure 8: Comparison of Production and Agricultural Gain of Maize Crop.

Wheat is the most important staple food crop in Pakistan, cultivated extensively across the country, with Punjab being the major wheat-producing province. Wheat production is closely monitored by the government to ensure food security and stabilize prices in the domestic market. It provides essential calories and nutrition to the population, making it a crucial component of Pakistan's food security strategy. Figure 9 shows the area, production, and yield of wheat crops. The area under wheat cultivation remained relatively stable over the years. Wheat

production increased steadily from 2018 to 2022. The yield of wheat per hectare also remained stable, with minor fluctuations.

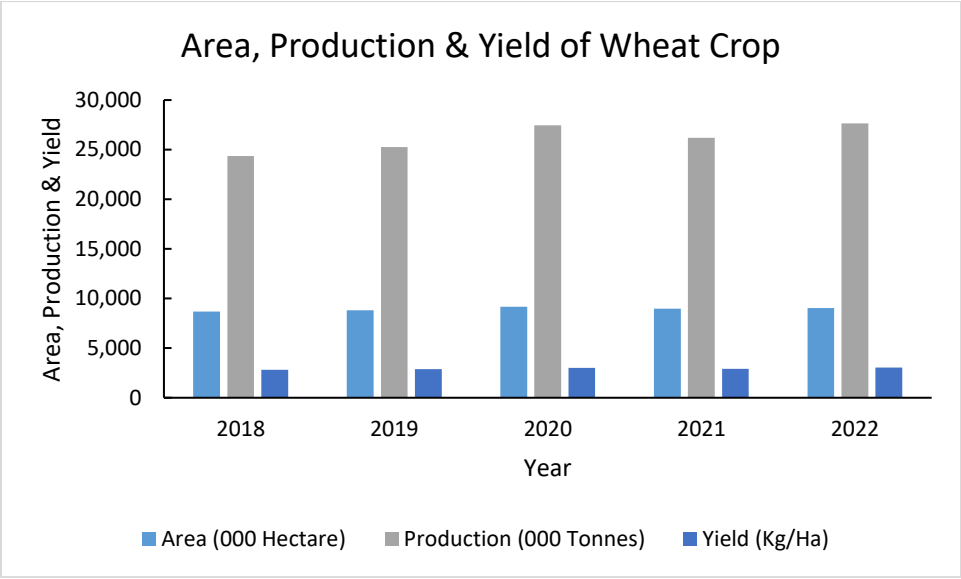

Figure 9: Area, Production & Yield of Wheat Crop.

The graph shows the relationship between wheat production (measured in thousand tonnes) and agricultural gain (expressed as a percentage) over the years 2018 to 2022. With an R^2 value of 0.0045, which indicates an inverse correlation, it suggests that there is no significant linear relationship between wheat production and agricultural gain. Figure 9 indicates that wheat production has generally increased over the years, with fluctuations observed from 2019 to 2021. However, agricultural gain, represented as a percentage, doesn't show a consistent pattern corresponding to the changes in production. For instance, in 2020, despite an increase in production, the agricultural gain remains relatively stable. Similarly, in 2022, although there's a slight increase in production, the agricultural gain decreases.

This suggests that factors other than production quantity, such as market conditions, input costs, or crop management practices, might have a more significant impact on agricultural gain. The weak correlation implies that changes in wheat production do not necessarily lead to proportional changes in agricultural gain, highlighting the complexity of the relationship between production and agricultural gain in the context of wheat cultivation.

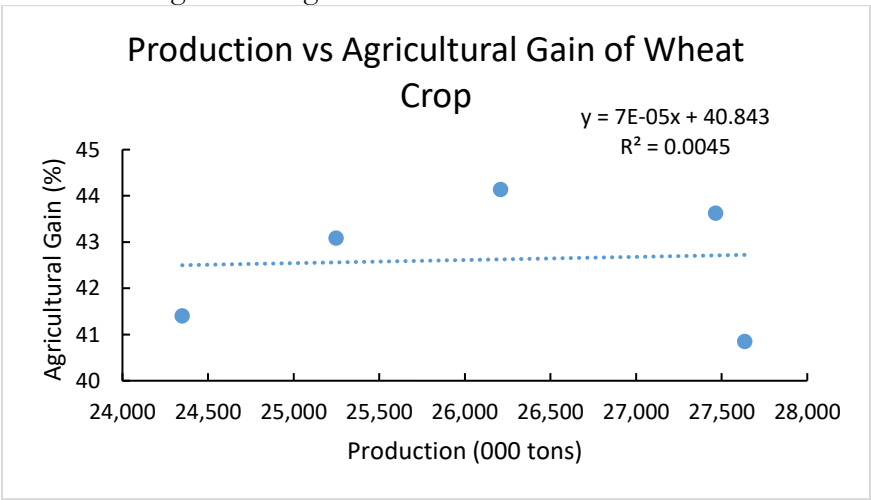

Figure 10: Comparison of Production and Agricultural Gain of Wheat Crop.

Among the crops listed in Table 1, there is a noticeable increasing trend in both production levels and contributions to GDP and agriculture value added for wheat. Over the

observed period, the wheat cultivation area has remained relatively stable but production has steadily increased, reaching 27,634,000 tonnes. Wheat's contribution to GDP has also seen a steady rise, reaching 1.9%, and it contributes significantly to agriculture value added, accounting for 8.2%. This upward trajectory suggests the growing importance of wheat cultivation in Pakistan's agricultural sector and its significant contribution to the country's economy.

Table 1: Major Crop Statistics in Pakistan: Area, Production, and Economic Contributions.

Crop	Area (000 ha)	Production (000 tonnes)	Contribution to GDP (%)	Contribution to Agriculture Value Added (%)
Cotton	2,144	4,910	0.3	1.4
Sugarcane	1,319	91,111	-	3.7
Rice	2,976	7,322	0.4	1.9
Maize	1,720	10,183	0.7	3.0
Wheat	9,043	27,634	1.9	8.2

Conclusion:

The analysis revealed several key findings indicating that cotton cultivation remains significant despite fluctuations, its correlation with agricultural gain is low. Sugarcane production shows steady increases, yet its relationship with agricultural gain appears weak. Rice production trends upward until 2021, but its correlation with agricultural gain is inverse. Conversely, maize cultivation demonstrates a strong positive correlation with agricultural gain, indicating higher production levels lead to increased profitability. Similarly, wheat production shows consistent growth, but its correlation with agricultural gain is insignificant. Overall, while the analysis offers insights, further investigation into factors beyond production levels is necessary to understand Pakistan's agricultural dynamics comprehensively.

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