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2 **Does Minor Crops (Bajra, Barley and Jowar) have** 3 **Significant Association to Agriculture Sector of** 4 **Pakistan? An Empirical Investigation**

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11 **Abstract:** This paper investigates and explores the minor crops production in Pakistan and its
12 association with the agricultural gross domestic product. The agriculture sector of Pakistan has a
13 rich contribution to the economic growth and development. Like major crops; minor crops also
14 have a vital role to boost up the agriculture sector. Time span data was used in this study and it was
15 collected from the Economy Survey of Pakistan annual reports. Augmented Dickey-Fuller (ADF)
16 unit root test and Ordinary Least Square (OLS) method was used to analyze the data and results
17 were interpreted by employing the Johansen co-integration test. Study results reveal that bajra,
18 barely and jowar has a significant impact on the agricultural gross domestic product, while the
19 total cropped area has a negative impact on AGDP. On the basis of the study results, we
20 recommend the policy implications.

21 **Keywords:** Pakistan; bajra; barley; jowar; crops production; agricultural gross domestic product

22

23 **1. Introduction**

24 The agriculture sector of Pakistan is playing an important role for the economic development; it is
25 contributing about 19% to the gross domestic product (GDP), and employing about 43% of the labor
26 force of the country and also has rich contribution to provide raw materials for the several
27 value-added sectors. It is playing a dominant role in the economic development, poverty alleviation
28 and food security. The fast development of urban areas in Pakistan specifies the demand the
29 high-value consumable products such as vegetables, fruits, dairy products, and meat is increasing. The
30 government is working to enhance and raise the productions these products by implementing new
31 policies to boost rural growers' through investment in the major infrastructure, including dependable
32 transportation networks and other structure chunks in contemporary supply chains (Rehman et al.
33 2015; GOP 2016).

34 The agricultural sector consists of five sub-areas, including major crops, minor crops, livestock,
35 forestry and fisheries. Agricultural grain and cereal crops include rice, corn, wheat, bajra, sweet
36 sorghum and barley (Raza and Mehboob 2012; Anwar et al. 2015). Minor crops in Pakistan include
37 Bajra, barely and Jowar (sweet sorghum). Major crops include such as cotton, wheat, rice, corn, sugar
38 cane, etc.; minor crops have also contributed to the development of the Pakistans agricultural sector.
39 Bajra (*Pennisetum glaucum*) is the most widely cultivated type of millet. Africa and South Asia have
40 been growing since the prehistoric times. Barley is also a cool season, fast-growing, an annual cereal
41 crop that can be used as a feed, as well as, to cover crops to enhance soil fertility. After corn, wheat,
42 rice, and soybeans, it ranks fifth in world food production (Manning and Fuller 2011; Miralles et al.

43 2001; Hussain et al. 2004; Zeid 2011; Ghanbari et al. 2012). Jowar (Sorghum) is a cultivated tropical
 44 grain grass. Today, jowar is cultivated around the world in warm climates. After corn, wheat, barley
 45 and rice, it is considered the fifth largest grain crop in the world. Farmers prefer to grow jowar
 46 varieties based on their ability and acclimate to numerous temperatures, rainfall, soil types and
 47 environmental situations (Mekbib et al. 2006). Furthermore, being as an important food and pasture
 48 crop, jowar (sorghum) having a dominant role in the production of raw materials for the production of
 49 fiber, starch, dextrose syrup, alcohol, biofuels, and other products. Jowar is planting in the semi-arid
 50 areas and more than half populations of the world is associated with this crop, and is considered the
 51 staple food of millions hungry and poor people (Mehmood and Gulfraz 2008). During the year
 52 2016-17, bajra crop production increased about 1.7% as compared to the same period in the previous
 53 year. Similarly, barley, jowar, mastard and tobacco crops production also increased with the ratio of
 54 9.8%, 7.5%, 3.2%, and 2.6% respectively, which showed a negative growth as compared to same period
 55 in the previous year due to decrease in sown area (GOP 2016).

56 Moreover, it is reported that between 1995 and 2020, the supply of agricultural water is expected
 57 to decrease in developing countries from 72% to 62%, and on a global scale, the decline of 87% to 73%
 58 is also projected (Khan and Blackwell, 2006). Since Pakistan is an agricultural country, the shortage of
 59 agricultural water have a negative impact on its economy, as this sector subsidizes directly its gross
 60 domestic product and more than 40% labor is linkage directly or indirectly associated with this sector
 61 (GOP 2008). Despite the severe crisis in the agricultural sector, including power shortages, weak
 62 infrastructure, developed agricultural markets and insufficient funding in this sector (Jan and Khan
 63 2012). It is imperative to increase agricultural production efficiency and use resources more efficiently,
 64 mainly inland, irrigation, and appropriate use of major inputs and available credit facilities (Iqbal and
 65 Ahmad 2002; Dong and Featherstone 2012; Faridi and Tahir 2015; Rehman et al. 2017).

66 The irrigation system in the Pakistan is the largest in the world for the agricultural production.
 67 The production of food is mainly dependent on the irrigation; it provides more than 90% production in
 68 the grain crops (FAO 2015). Compared with other developing countries, the agricultural production
 69 has declined, but its growth rate is maintained through technological advancement, grants and
 70 agrarian research. As a result, the annual growth rate of the agricultural sector in the economy is
 71 considerable 5.1% (Ahmed and Gill 2007; Rehman et al. 2016). The main focus of this study was on the
 72 minor crops production including bajra, barley and jowar and its association with AGDP (agricultural
 73 gross domestic product). Besides the introduction section, the remaining sections of the paper include;
 74 methodology, results and discussion and final is conclusion and policy implications. The trends of the
 75 variables including area under bajra, area under barely and area under jowar are reported in figure 1.
 76 The production trend of bajra, barley, and jowar are presented in figure 2.

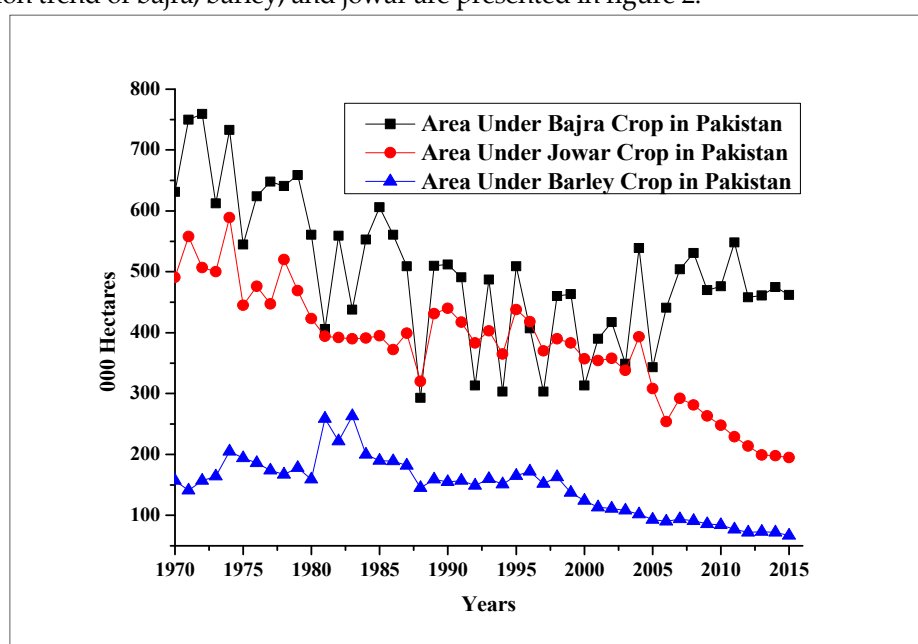
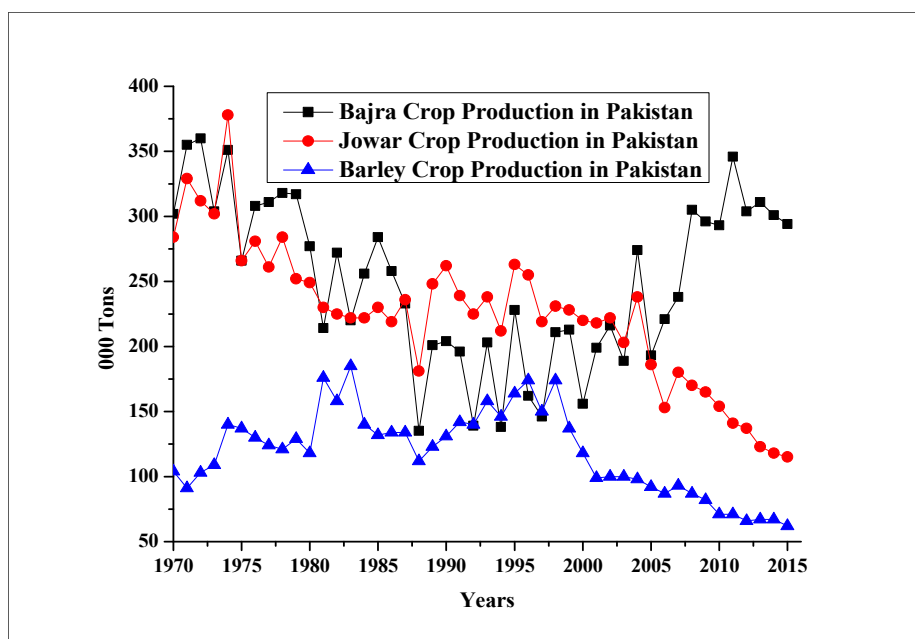


Fig 1. Area under minor crops in Pakistan from 1970-2015.



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Fig 2. Minor crops production in Pakistan from 1970-2015.

81 2. Methodology

82 2.1. Data Sources

83 In this paper time span data was used from 1970-2015, and it was gathered from the Economy
 84 Survey of Pakistan. The variables used in this paper are minor crops including bajra, barley, jowar,
 85 total cropped area and agricultural gross domestic product.

86

87 2.2. Empirical Model

88 The following model was specified to check the relationship between minor crops, total
 89 cropped area and agricultural gross domestic product:

$$90 \quad M = f(R_1, R_2, R_3, R_4) \quad (1)$$

91 Where,

$$92 \quad M = \text{AGDP}, R_1 = \text{BAJRA}, R_2 = \text{BARLEY}, R_3 = \text{JOWAR}, R_4 = \text{TOTAL CROPPED AREA}$$

93 We can also write Equation (1) as:

$$94 \quad \text{AGDP} = f(\text{BAJRA}, \text{BARLEY}, \text{JOWAR}, \text{TOTAL CROPPED AREA}) \quad (2)$$

95 The log-linear stipulations of the variables have been used and the following equation has been
 96 estimated (equation 3);

$$97 \quad \ln(\text{AGDP}) = \phi_0 + \phi_1 \ln(\text{BAJRA}) + \phi_2 \ln(\text{BARLEY}) + \phi_3 \ln(\text{JOWAR}) \\ 98 \quad \quad \quad + \phi_4 \ln(\text{TOTAL CROPPED AREA}) + \mu_t \quad (3)$$

99 Where AGDP indicates the agricultural GDP in million rupees, ϕ_0 = natural logarithm of A, the
 100 intercept; $\ln(\text{BAJRA})$ indicates the natural logarithm of the production output of bajra (in 000
 101 tonnes); $\ln(\text{BARLEY})$ indicates the natural logarithm of production output of barley (in 000 tonnes);

102 $\ln(\text{JOWAR})$ indicates the natural logarithm of the production output of jowar (in 000 tonnes); \ln
 103 $(\text{TOTAL CROPPED AREA})$ indicates the natural logarithm of total area used for the crop
 104 production (in 000 hectares); and μ_t is the error term.

105 2.3. Ordinary Least Square Method

106 The predictive ability of the model is measured by employing the OLS (Ordinary Least Square)
 107 method and it provides the parameter for the short-run relationship and for the analysis of the
 108 long-run among the variables Johansen co-integration test was applied.

109 3. Results and Discussion

110 This section may be divided by subheadings. It should provide a concise and precise
 111 description of the experimental results, their interpretation as well as the experimental conclusions
 112 that can be drawn.

113 3.1. Descriptive Analysis and Results of ADF Unit Root Test

114 ADF (Augmented Dickey-Fuller) unit root test was applied to check the stationarity of the
 115 variables. Table 1 reports result of the descriptive statistics and table 2 represents the ADF test
 116 results. The descriptive statistics results revealed that the minor crops including bajra, barely and
 117 jowar has a substantial impact on the AGDP.

118 **Table 1.** Descriptive Statistics of the Variables

Variables	Mean	Median	Maximum	Minimum	Std. Dev.
AGDP	12.37545	11.71063	14.60880	10.95063	1.393530
LNBAJRA	5.488980	5.549068	5.886104	4.905275	0.271154
LNBARLEY	4.739877	4.803988	5.220356	4.127134	0.291463
LNJOWAR	5.381146	5.422723	5.934894	4.744932	0.265962
LNTOTALAREA	6.910184	6.948868	7.331060	6.584791	0.211070
Observations	46	46	46	46	46

119

120 **Table 2.** ADF Unit Root Test including (Trend and Intercept)

Variables	At level		First Difference	
	t-Statistic	Critical values	t-Statistic	Critical values
LNAGRGDP	-2.123962 (0.5189)	1% -4.175640 5% -3.513075 10% -3.186854	-6.967640*** (0.0000)	1% -4.180911 5% -3.515523 10% -3.188259
LNBAJRA	-1.636601 (0.7619)	1% -4.180911 5% -3.515523 10% -3.188259	-7.725612*** (0.0000)	1% -4.186481 5% -3.518090 10% -3.189732
LNBARLEY	-1.861383 (0.6577)	1% -4.175640 5% -3.513075 10% -3.186854	-8.884715*** (0.0000)	1% -4.180911 5% -3.515523 10% -3.188259
LNJOWAR	-3.067747 (0.1263)	1% -4.175640 5% -3.513075 10% -3.186854	-7.383166*** (0.0000)	1% -4.186481 5% -3.518090 10% -3.189732

121 Note: *** shows 1% of significance level

122 3.2. Co-integration Test Results

123 Johansen co-integration test results including trend and intercept are presented in the table 3.
 124 Test results revealed a long-run equilibrium among the study variables. Trace statistic and the

125 Max-Eigenvalue statistic revealed one (1) co-integrating equation at the 1% and 5% level of
126 significance.

127 **Table 3.** Results of the Johansen Cointegration test using Trace Statistic and Maximum Eigenvalue

Trace Statistic				
Null Hypothesis	Alternative Hypothesis	Test Statistic	5% Critical value	Prob.**
H0: $r \leq 0$	H1: $r > 0$	73.47170**	69.81889	0.0248
H0: $r \leq 1$	H2: $r > 1$	34.36530	47.85613	0.4820
H0: $r \leq 2$	H3: $r > 2$	19.75163	29.79707	0.4398
H0: $r \leq 3$	H4: $r > 3$	9.838457	15.49471	0.2934
H0: $r \leq 4$	H5: $r > 4$	0.308912	3.841466	0.5783
Maximum Eigenvalue Statistic				
Null Hypothesis	Alternative Hypothesis	Test Statistic	5% Critical value	Prob.**
H0: $r \leq 0$	H1: $r > 0$	39.10640***	33.87687	0.0108
H0: $r \leq 1$	H2: $r > 1$	14.61368	27.58434	0.7781
H0: $r \leq 2$	H3: $r > 2$	9.913169	21.13162	0.7528
H0: $r \leq 3$	H4: $r > 3$	9.529545	14.26460	0.2447
H0: $r \leq 4$	H5: $r > 4$	0.308912	3.841466	0.5783

128 Note: ** and *** denote rejection of the hypothesis at 5% and 1% significance level

129 3.3. Results of Regression Analysis

130 Table 4 reports the results of the regression. The value of R-squared was 0.886, and the adjusted
131 R-squared was 0.874. The F-statistic computed value was 79.72613 with a p-value of 0.0000. The
132 model demonstration shows the overall goodness to fit.

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Table 4. Regression Analysis

Dependent Variable: LNAGDP				
Method: Least Squares				
Included Observations: 46				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	49.05655***	2.756994	17.79349	0.0000
LNBAJRA	3.899168***	0.883675	4.412446	0.0001
LNBARLEY	0.048103	0.617026	0.077959	0.9382
LNJOWAR	2.709878***	0.968824	2.797079	0.0078
LNTOTALAREA	-10.54875***	1.787755	-5.900558	0.0000
R-squared = 0.886081		Adjusted R-squared = 0.874967		
F-statistic = 79.72613		Prob(F-statistic) = (0.0000)		
Durbin-Watson stat = 1.722401				

138
139 Table 4 demonstrates the results of the regression analysis, and results shows that the
140 coefficient of the bajra has a significant and positive relationship with AGDP. The results also show
141 that the barely also has a positive impact on the AGDP, but statistically is non-significant with
142 having p-value 0.9382. Similarly results also revealed that jowar crop also has a positive and
143 significant relationship with the AGDP. The results of the total cropped area shows a negative
144 association with the agricultural gross domestic product. It was not expected but may be the reason

145 for the negative relationship variations in the climatic condition, land degradation and water
146 availability.

147 4. Conclusion and Policy Implications

148 The agriculture sector in the Pakistan has dominant role in the economic development and also
149 has a rich contribution to boost the economy. In this paper, we investigated the relationship of minor
150 crops including bajra, barley and jowar and their contributions to the AGDP (agricultural gross
151 domestic product). Agriculture sector is measured as the mainstay of Pakistan economy; it has a rich
152 contribution to the economic development. ADF unit root test and OLS method was applied on the
153 time span data to measure the stationarity. Johansen co-integration test was applied to interpret the
154 results. The study results show that the bajra crop has a positive and significant impact on the
155 AGDP. Results also show that the barley crop has a positive but non-significant influence on the
156 agricultural gross domestic product. Similarly, jowar crop also has a constructive and substantial
157 impact on the agricultural gross domestic product, but the coefficient of the total cropped area has a
158 negative impact on the AGDP. According to the study results, it is necessary that Pakistan's
159 government should implement new policies and subsidy schemes to boost the sector of these minor
160 crops. Following policy implications should be implemented:

- 161 • Adoption and development of new varieties.
- 162 • Attention needed to reduce post-harvest losses.
- 163 • Provide easy access to the farmers to obtain agricultural credits to purchase seeds and
164 fertilizers.
- 165 • To enhance the water supply inefficient way through proper and better water
166 management.
- 167 • To make an investment in the scientific research, development, and extension.
- 168 • Provide easy access to the markets for buying seeds, fertilizers, farm mechanization,
169 credit, water.

170 **Author Contributions:** A. R. conceived the study, collected the data, estimated the econometric model and
171 drafted the manuscript. A.A.C read and made suggestions and finalized the manuscript. All authors read and
172 approved the final manuscript.

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