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Research Article

Economic Perspectives of Maize Crop in Pakistan: A Time Series Analysis (1970-2015) (Part 3)

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ABSTRACT:

This study examines the relationship between output of maize crop, area under maize crop and agricultural gross domestic product (GDP) in Pakistan using a time series data ranging from 1970 to 2015. The study used Phillips Perron (PP) unit root test for checking the stationary of the data. Johansen co-integration test have been used to examine the long run relationship among dependent and independent variables. Ordinary Least Square (OLS) technique has been used to estimate the relationship among output of maize crop, area under maize crop and agricultural GDP. It finds that output of maize crop and area under maize crop had a positive and significant relationship with agricultural GDP. Estimation reveals that at 1% increase in output of maize crop agricultural GDP increased by 0.77% and at 1% increase in area under maize crop bring 3.88% increase in agricultural GDP. The explanatory variables (output of maize crop and area under maize crop) have positive impact on agricultural GDP.

Keywords: Output of Maize, agricultural GDP, Co-integration, OLS, Maize Production and Inorganic Fertilizers

[1]INTRODUCTION

Maize crop is another cash crop of Pakistan as compared to other food grains. Maize crop contributes 2.1% to agriculture value added and 0.41% to gross domestic product (GDP). 2013-14 estimates shows that it was cultivated on an area of 1117 (000 hectare) and increased 5.4% over the last year which was 1060 (000 hectare). The production of maize crop during 2013-14 stood at 4528 thousand tones which showed an increase of 7.4% against last year (Pakistan, 2013-14). Maize crop ranks third in the world with an area of more than 118 million hectares with production about 600 million metric tones. Maize is fourth largest cultivated crop of Pakistan after wheat and rice. Punjab province of Pakistan contributes 40% of the total area under maize crop production as compared to NWFP, Sindh and Balochistan (GOP, 2013-14). There is an increased interest shown by farmers and researchers that rotation in crop and management of crop residues examined different value management tools. Many research studies has clearly showed that appropriate addition of organic materials are most important for maintaining the soil fertility, tilth, and agricultural productivity and also controlling wind and water erosion and by preventing nutrient losses by run-off and leaching (Bukert, Bationo, & Possa, 2000; Lal, 1980). Despite of these advantages, farmers prefer to remove crop stubbles from the field and use them as a fuel and fodder for their livestock or

as building materials. In contrast to sustainable farming system, farmers use these stubbles for mulching and to improve the soil physical and chemical properties hence increase soil organic matter. Soil organic matter plays a vital role in replenish soil chemical and physical properties and it is necessary to include legumes in crop rotation and retain crop residues.

Inorganic fertilizers play an important role in producing high yield worldwide and nitrogen fertilizer (N) is applied in bulk quantity as it is required in great proportion during the plant life cycle. The application of Nitrogen fertilizer is the main and major source of N input in the crop cultivation system world-wide. According to estimation, presently, 50% of human population depends on N fertilizer for food production while 60% of nitrogen is utilized in producing three food crops: rice, maize and wheat (Ladha, Pathack, Krupnik, Six, & Kessel, 2005). Unfortunately, it is also evident that applied nitrogen fertilizer is not efficiently utilized by the plants and is lost through volatilization and leaching causing serious threats to water and terrestrial environments while recovery of this nitrogen only accounts for 50% of applied nitrogen and in cereals, nitrogen recovery just accounts for only 40% on global basis (Fageria & Baligar, 2005; Ruan & Johnson, 1999; Ruan, et al., 2002). Fageria and Baligar (2005) described that low recovery of nitrogen fertilizer is due to its volatile property which is associated with leaching, denitrification and soil erosion. Additionally, the dynamic nature of nitrogen, its mobility in plants, and transformation processes in soil make it an element that is not efficiently utilized.

Furthermore, Ruan and Johnson (1999) studies shows that 67% of total functional nitrogen is being lost with worth of $15.9 billion annually and even only 1 percent increase in nitrogen salvage can result in global savings of $234 million (Glass, 2003). Therefore, the use of nitrogen efficiency (NUE) of applied nitrogen fertilizer is a real concern to researchers engaged in N cycling and transformations. For nitrogen efficiency improvement in crop production, N management approaches should take into account for the improvement of fertilizer efficiencies along with soil and crop management practices. Among these management practices, adequate rate, appropriate uses of fertilizer, and timing of fertilizer application during crop growth cycle play a vital role (Abbasi, Tahir, Sadiq, Iqbal, & Zafar, 2012). Such strategies not only boost production but also reduce cost of production and environmental hazards.

Mineral nutrition plays an important role in crop production and among the plant nutrients, nitrogen is of great importance in crop productivity (Ahmad, 1998, 2000; Zapata & Cleenput, 1986) and nitrogen deficiency is one of the potent reasons for limiting yield in cereals (McDonald, 1989; Shah, Shah, Peoples, Schwenke, & Herriedge, 2003). Continuous cereal cropping system poses nitrogen deficiency through decomposition of inorganic fertilizer and this deficiency should be overcome through supplementation from other sources (Herridge & Doyle, 1988; McDonald, 1992; Strong, Harbison, Nielson, Hall, & Best, 1986b).

In most development countries, sufficient nitrogen fertilizer is applied as inorganic fertilizer, however, in some developing countries like Pakistan, it is not conceivable due to high price of fertilizer, less availability of credit and low farm income to farmers hence yield is hindered due to these types of factors. As a consequence, due to limited sources, farmers can use the available organic sources or the crop remains unfertilized (Herridge, et al., 1995b). In disparity to the developed countries, farmers of developing countries especially in Pakistan are indispensably inclined to use commercial fertilizer to satisfy the required level of plant mineral nutrition. During the last few years, the prices of fertilizer in most developing countries have reached unprecedented high whilst supply has been limited when the sowing time is approached (Shah, et al., 1995). This has resulted in failure to attain target yields and national production potential.

In cereal cropping system, there should be inclusion of legume crop to overcome the nitrogen deficiency which can play a vital role in maintaining soil fertility as well and sustaining crop production. Leguminous crops have ability to fix atmospheric nitrogen into organic nitrogen through their modulated roots and hence prove to be a valuable source of organic N (Giller, 2001; Munyinda, Karamanos, & O'Halloran, 1988; Peoples & Craswell, 1992).

[2] PRODUCTION AND AREA USED FOR MAIZE CROP

Area under maize crop in 1000 hectares and area yield in kg/ hectares of Pakistan are showed in Fig. 1 and Fig. 2.

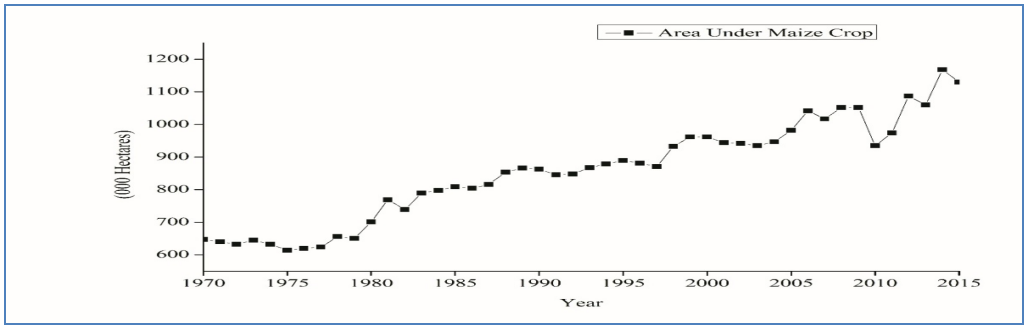

Fig. 1: Area under maize crop 1970-2015

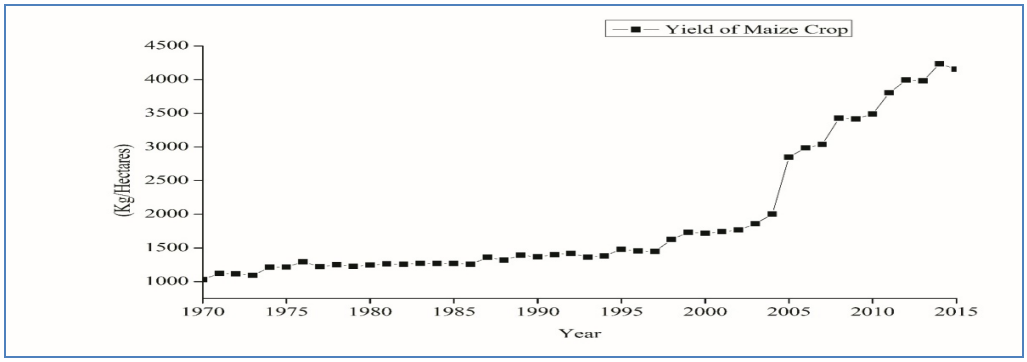

Fig. 2: Yield of maize crop in kg/hectares 1970-2015

[3] MATERIALS AND METHODS

This study examines the relationship between output of maize crop, area under maize crop and agricultural GDP of Pakistan over the period of 1970-2015. Time series data have been collected from Pakistan Statistical Year Book (various issues). The Phillips Perron (PP, 1988) unit root test has been employed for checking the stationarity of the data including trend and intercept which is appropriate for such finite sample (Malik and Chaudhry, 2001). Variables, which are not stationary at their level form, again we have to check stationary of the series after taking first difference. Moreover, the Johansen Co-integration (1990) test has been used to examine the long-run relationship among dependent variable and independent variables. To this end, Trace Statistic and Max-Eigen Statistic have been used.

In order to investigate the relationship between output of maize crop, area under maize crop and Agricultural GDP, the following model has been estimated.

$$ln\ (AGRGDP) = \beta_0 + \beta_1\ ln\ (OPMAIZE) + \beta_2\ ln\ (ARMIAZE) + \mu \ldots\ (1)$$

Where

Ln *(AGRGDP)* = natural log of Agricultural Gross Domestic Product per year in (million rupees)

Ln (OPMAIZE) = natural log of output of maize crop in (000, tones)

Ln (ARMAIZE) = natural log of area under maize crop (000, hectare)

μ = error term

[4] RESULTS AND DISCUSSION

(a) P-P Unit root test

The results of P-P unit root test have been reported in Table 1. In Table 1, the stationary of the data has been checked including trend and intercept. According to Table 1, (AGRGDP) and (OPMAIZE) are non-stationary at level while (ARMAIZE) is stationary at level. Furthermore, for stationary of (AGRGDP) and (OPMAIZE) we have again checked and AGRGDP and OPMAIZE became stationary after taking the first difference I (1), as indicating the values of Adj. t-Stat test are larger than the Critical values at the 5% of significance level.

Table 1: P-P unit root test results including (trend and intercept)

Variables	At level		First Difference	
	Adj. t-Stat	Critical values	Adj. t-Stat	Critical values
LnAGRGDP	-2.098322 (0.5327)	1% -4.175640 5% -3.513075 10% -3.186854	-7.036702* (0.0000)	1% -4.180911 5% -3.515523 10% -3.188259
LnOPMAIZE	-5.107750* (0.0007)	1% -4.175640 5% -3.513075 10% -3.186854	-12.19341* (0.0000)	1% -4.180911 5% -3.515523 10% -3.188259
LnARMAIZE	-3.055330 (0.1293)	1% -4.175640 5% -3.513075 10% -3.186854	-7.564435* (0.0000)	1% -4.180911 5% -3.515523 10% -3.188259

Note: *, **, *** represents1%, 5%, 10% of significance level

(b) Co-integration test

Moreover, the regression results may be spurious due to no co-integration among the study variables. For this purpose, the Johansen Co-integration tests have been used including Trace statistic and Max-Eigen Statistic. The values of trace statistic and Max-Eigen statistic are given in Table 2 and 3, which indicates the long run relationship between output of maize crop, area under maize crop and agricultural GDP of Pakistan over the period of 1970 and rejects the null hypothesis of no co-integration. Because the values of trace statistic and Max-Eigen statistic are larger than their relevant critical values which shows the existence of one co-integrating equation at 5 percent.

Table 2: Co-integration test Results

Eigenvalue	Trace Statistic	5 Percent Critical Value	Prob.**	Hypothesized No. of CE(s)
0.471788	35.75211	29.79	0.00	None *
0.224375	10.22178	15.49	0.26	At most 1
0.001458	0.058354	3.84	0.80	At most 2

Trace test shows 1 co-integrating equation at the 0.05 level,*denotes rejection of the hypothesis is at the 0.05 level.

Table 3: Co-integration test Results

Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	Prob.**	Hypothesized No. of CE(s)
0.471788	25.53033	21.13	0.01	None *
0.224375	10.16342	14.26	0.20	At most 1
0.001458	0.058354	3.84	0.80	At most 2

Max-eigenvalue test shows 1 co-integrating equation at the 0.05 level,*denotes rejection of the hypothesis is at the 0.05 level.

(c) Regression Analysis

In order to investigate the relationship between outputs of maize crop, area under maize crop and agricultural (GDP) in Pakistan over the period of 1970-2015, an econometric, Ordinary Least Square method has been used. Regression results are presented in Table 4. The results showed that the coefficient of output of maize crop is highly significant at both 1% and 5% of significance level, which shows that there is a positive and significant association ship among agricultural GDP and output of maize crop. This means that 1 percent increase in output of maize crop agricultural GDP increased by 0.77%. Our results according to Anyanwu et al found out that the positive relationship between output of maize crop and Agricultural GDP. Furthermore, the results showed that the coefficient of area under maize crop is also significant at both 1% and 5% of significance level, which showed that there is positive and significant relation between area under maize crop and agricultural GDP. This implies that a 1 percent increase in area under maize crop brings 3.88% increase agricultural GDP.

Table 4: Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-19.43553	5.008390	-3.880594	0.0004
LNOPMAIZE	0.772987	0.226748	3.409011	0.0014
LNARMAIZE	3.882904	0.932303	4.164851	0.0001
R-squared	0.789029	Adjusted R-squared	0.779216	
F-statistic	80.40951	Prob(F-statistic)	0.000000	
Durbin-Watson stat	0.724758			

The high value of R^2 is (0.78). This suggests that about 0.78 % of total change in agricultural Gross Domestic Product (GDP) have been described explanatory variables (Output of maize crop and area under maize crop). The calculated value of F-statistic is 80.40951 with the probability values of 0.000000 which shows that the overall fit of model is good.

5. CONCLUSION AND RECOMMENDATIONS

This study showed econometric results and examined the relationship between output of maize crop, area under maize crop and agricultural GDP in Pakistan over the period 1970-2015. Time series data was collected from Pakistan Statistical Year Books and Economic Survey of Pakistan (various issues). In order to analyses that data Phillips Perron (PP) unit root test, Johansen co-integration test and OLS method were applied. The results of Co-integration test revealed that there exists a long-run relationship between output of maize crop, area under maize crop and agricultural GDP of Pakistan. The results of regression analysis showed that at 1 percent increase in output of maize crop brings 0.77% increase in agricultural GDP. Furthermore, one percent increase in area under maize crop agricultural GDP increased by 3.88%.The explanatory variables (output of maize crop and area under maize crop) have contributed positively towards agricultural GDP of Pakistan.

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