

## **ECONOMIC STANCE OF WHEAT CROP YIELD IN PAKISTAN: APPLICATION OF ARDL BOUND TESTING MODEL**

**Abdul Rauf<sup>1,\*</sup>, Xiaoxing Liu<sup>1</sup>, Muddassar Sarfraz<sup>2</sup>, Khurram Shehzad<sup>3</sup> and Waqas Amin<sup>4</sup>**

<sup>1</sup>Department of Finance, School of Economics and Management, Southeast University, Nanjing, China.; <sup>2</sup>Business School, Hohai University, Nanjing, Jiangsu, PR China; <sup>3</sup>Government College University Faisalabad, Faisalabad, Pakistan; <sup>4</sup>School of Economics, Shandong University, Jinan, China

\*Corresponding author's e-mail: [abdulraufhcc@gmail.com](mailto:abdulraufhcc@gmail.com)

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The prime aspire of this research study is to delve into the nexus of wheat crop production, agriculture area specifically for the wheat crop, fertilizers consumption and gross domestic product (GDP) of Pakistan. Agriculture is the spine of Pakistani economy and contributed toward total GDP at enormous scale. Annual data retrieved for analysis that is ranging from 1981 to 2015. Augmented Dicky Fullers (ADF) unit root test employed to check the stationary level of the four variables. Unit root test indicated that all variables are non-stationary, so results of unit root propagated that two variables are stationary at level whereas two are on first difference. Thus, it is an appropriate environment to employ the Autoregressive Distributed Lag model (ARDL) which can extract the long run and short results simultaneously. The results of the ARDL showed that the coefficient of wheat crop area was hugely significant at 5% significance levels concerning agricultural GDP, indicating a powerfully positive and significant relationship between these variables. But for crop wheat yield and fertilizer consumption for wheat provided insignificant results that means there is no any association between them. Finally, results suggested that in future the wheat yield crops and fertilizers usage in a way which may help to increase the GDP level of national economy of Pakistan.

**Keywords:** ARDL, Wheat Crop Yield, AGDP, Fertilizer Consumption, Wheat Crop Area, Pakistan.

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### **INTRODUCTION**

In this era of globalization and interconnectivity of the countries in this world, make life well-being and dissemination of information from one edge of the world to another segment. For the assessment of economic growth of a country, there are many sectors of importance such as agriculture, services industry, manufacturing, medicine and much more others, which may add their participation in the gross domestic product (GDP) calculation. Different countries have their distinct competitive edge to make this specific country extendable growing and achieve the aim of sustainable development. Wheat, Rice, and Cotton are vital cereal crops in different countries according to their regions. Wheat and rice are a staple food for many countries in Asia, Africa, America, Europe and in other continents as well.

Pakistan Vision 2025 visualizes seven precedence zones of accomplishment labeled as "Pillars" 6<sup>th</sup> Pillar is termed as "Water, Energy and Food Security." It envisions hallucination and tender plan for future development and advancement of Agricultural and Food segments along with associated subsectors. Pakistan is a country which positioned in Asian regions especially in South Asia encircling by Iran, India, China, and Afghanistan from four sides. Pakistan is a developing country which is having dependency on agriculture sector, furthermore gross domestic product (GDP) chiefly contributed to agriculture production and cash crops realization funds. Agriculture founds the prime segment of

Pakistani economy whereas, the mainstream of the masses, in a straight line or indirectly, reliant on this section. It weighs in about 24% of gross domestic product (GDP). It is valued at 3.46% and provided half of employment to the labor force. In addition it is also consider a vital source of incomes inform of foreign exchange, realized by exporting these agricultural cereals crops to other countries in the world. Moreover, it also proven derentire countryside and local population in all areas of the country. Comprehending its standing, proposers and policymakers are continually acute to have consistent area and yield production for different cereal crops and agricultural items. Policy makers are mostly prerequisite to accurate and sensible statistical numbers for the important crops such as rice, wheat, cotton, sugarcane and maize etc.

The revival of the agricultural segment also had a positive spillover into the manufacturing sector, predominantly the Large-scale Manufacturing (LSM). An outpouring of sugarcane yield led to best sugar production in the nation, which navigated LSM to realize 5.7 % growth throughout the year 2017. The general agriculture sector bounce back powerfully, as it recorded a progress of 3.5 % in 2017 equated to a nominal upsurge of 0.3 % in the preceding year. A remarkable retrieval in vital crops clarifies this performance (GOP, 2017). Indeed, this was a prominent feat given that the zone under significant crops had deteriorated, and the water convenience endured lesser than hopes. Crossways the panel up surge in crop yields, mostly driven by an extensive escalation in fertilizer usage and government backing (e.g.,

provide subsidized fertilizer, striking support prices for wheat and sugarcane also lesser the taxes on pesticides for crops), enabled the significant harvests to post a notable recapture in their yield production. Supplementary, sustenance hail from livestock (the highest sub-sector inside agronomy) that sustained in preceding year's development of 3.4 % in 2017 (SBP,2017).

There are two primary imperious fragments in different cereals crop production, which is reliability and sustainability for these crops production (Rehman *at el.*, a2017). Furthermore, they propagated that energy and water hoard considered a vital complementary source to grow colossal wheat production, also the future stage of development on that planet, even a triggering force to make these two aspects in a clear demonstration, to achieve sustainability and reliability in this economic development race. These two slices for wheat products such as, energy conservation and water resources are chief concerns for scholars and agriculturists, to mend the way for lessening these two sources in a stream which would not fraught on the crops production.

The golden period which Pakistan experienced in in 1980 when the water management and irrigation system upgraded through canal construction projects. Though, the subsequent outcomes of scarcity have had strained canal irrigated system badly. In this period of water dearth tremor, the country faced a lot of hitches to regaining from this water scarceness time span which persisted for three years from 1999 to 2002 (GOP, 2008). This shortage in water instigated the abundant usage of pounded water through the impelling of surfaced water and usage of bores, which consumed a high magnitude of available energy in spite of the country facing hurricane difficulties in the provision of this merchandising as well.

Rehman executed research study on the country Pakistan with variables such as, wheat crop yield, area for the wheat crop in hectares and agriculture GDP by employing simple OLS model for analysis that indicated the relationship between wheat crop yield and agriculture GDP but on another hand area for wheat crop insignificant association with Agricultural GDP. Simple OLS model may lead spurious regression results to check the authentication of results in the long run, and short modern econometrics techniques would apply to enumerate the results and further to add the fertilizer consumption for wheat crop yield as an additional variable for this recent research study.

The underlying theme this research study to examine the bond between wheat yield crop, the area under wheat crop, fertilizers consumption and Agriculture GDP concerning Pakistan. The time span for this study is encircling from 1981 to 2015. Some data is missing in the fertilizer consumption to cater this problem cubic spline techniques used to fill these missing interpolation values for that variable. Unit root test initially explored and after that a very renowned procedure for analysis employed which is termed as ARDL bound testing approach (Shahbaz *et al.*, 2012, 2013). Also results in

consistency and implications for productive policy-making and agricultural reforms could be helpful. This subsequent section will envisage the previous literature, Methodology and model specification embed in section 3, section 4 enclosed for results and discussions whereas, final section 5 will sketch the picture for concluding remarks and policy implications.

## LITERATURE REVIEW

Agriculturists are fronting a massive challenge to come across the food necessities for the masses of nine billion from the middle of the 21st century (FAO, 2009). Production of extra food since less water in parched and semi-arid zones is one specific test for these days' agronomy (Shideed, 2011). Additionally, (Khan *et al.*, 2006) elaborated that accessibility of water for the agricultural segment is anticipated to declining trend from 72 % to 62% from spanning 1995 to 2020 that could be alarming with regard of a shortage of food in future. Developing countries are, at hitting scratch from that problem explicitly and expected there would lessen the accessibility of water from 87% to 73% for them shortly (Rehman *et al.*, 2015) Explored the development of agriculture sector in China with a comparison of India and Pakistan from 2013 to 2015.

China has become the most famous manufacturing hub by introducing the economic reforms in 1978, an Industrial sector of China has the most significant share in GDP now. GDP (purchasing power parity) of China is increasing day by day as it was 17.02 trillion dollars in 2013, 18.27 trillion dollars in 2014 and 19.51 trillion in 2015. While the growth rate of real GDP of China has declined in these years, as it was 7.7% in 2013, in 2014, it decreased to 7.3%, and in 2015 it was 6.8%. Per capita GDP of China was \$12400, after that it increases to 13400 USD in 2014 and then increased to 14300 in 2015. Percentage of gross national saving in China was 48.20 in 2013, in 2014 it increased up to 48.50% and then declined to 47.40% in 2015. The author reported that China had become the second more significant economy of the world, but still it is developing country because its market reforms are incomplete. The study also concluded that unemployment rate in China is decreasing these days.

Moreover, (Rehman *et al.*, 2016) discovered that the agriculture and economic development of Pakistan and compare it with the growth in China, Japan, Bangladesh, Russia, and India. More than 46% of the people are connected with agriculture in Pakistan, and it is the most comprehensive sector of Pakistan. Agriculture sector of Pakistan contributes 26% to the national economy of Pakistan. Major agriculture products of Pakistan are wheat, milk, cotton, sugar and edible oil; hence it becomes the key source of income for the rural areas of Pakistan. In rural areas of Pakistan agriculture sector employed 68% of the population. The author concluded that agriculture sector of Pakistan contributes the 25% in the gross domestic product. GDP of Pakistan is gradually decreasing as

it was 50% in 1949-50 and 24% in 1996-1997. The study reported that national saving of India is decreasing while in case of Japan it increased. Real GDP of Japan was 0.80% in 2013 after that it increased the ratio of 1.60% in 2014.

Rehman investigated the effect of wheat income on the agriculture GDP in Pakistan. Author has used the time series data of 45 years from 1970 to 2015. Study implied the Philips perron technique including the trend and intercepted to evaluate the stationary of the variables and used the Johansen co integration technique to check the co-integration between the variables and OLS used to assess the actual results of the data. The study found that wheat crop yield and agriculture GDP have a positive and significant relationship as there is one percent increase in the wheat crop yield it will bring 7.01% increase in the agriculture GDP. The study reported the negative relation between agriculture GDP and area for the wheat crop.

Raffia cartoon and BabarShahzad explored the financial crisis impact on the development of agriculture sector in Pakistan. The study reported that growth rate of GDP in Pakistan is going down and also said a deficit of current account. The study also indicated that inflation had decreased the GDP growth rate in Pakistan, it was 6.8% in 2007, but in 2008 it goes down to 4.1%.

Ali *et al.* (2016) examined the effect of expenditure on the growth of agriculture sector and economy for the period of 1983 to 2011 by using the time series data. The study used the ADF test to evaluate the unit root in the data. The study used the co integration technique and OLS to analyses the data and found that there is a significant relationship between GOVT expenditure, agriculture output and economic growth of Pakistan. The study suggests that GOVT should increase the spending on the agriculture sector.

## MATERIALS AND METHODS

In this study, data gathering process executed in national and international sources of information. Secondary datais collectedinternal form source (Pakistan Statistical Bureau (PSB), 2017), Economic survey reports and publication from Federal Bureau of Statistics (FBS), 2017) and externally grounded data for variables collected from (World Development Indicators (WDI), 2017) for aligning data series. In this research inquiry, four variables emerged as an econometric model such as; wheat crop yield, area for wheat crop, fertilizers consumption and agricultural gross domestic product (GDP) in percentage see as (Rehman *et al.*, 2017, b2017). The extraction of results from this model will propagate the production level of the wheat crop in future; it also specifies fertilizers contribution for GDP and its implications in the agriculture of Pakistan. Firstly, the variables are gauged on the basis of their stationarity level by using different unit root test such as, Augmented Dicky Fuller (1979) (ADF) unit root test to restricted the sample in trend

and intercept format (FAO, 2001), from these estimations it was derived that two variables are non-stationary at level but as these transformed into the first difference these predictors and predicted variables become stationary at level and difference. This indication perused to rub on ARDL model for examination drive.

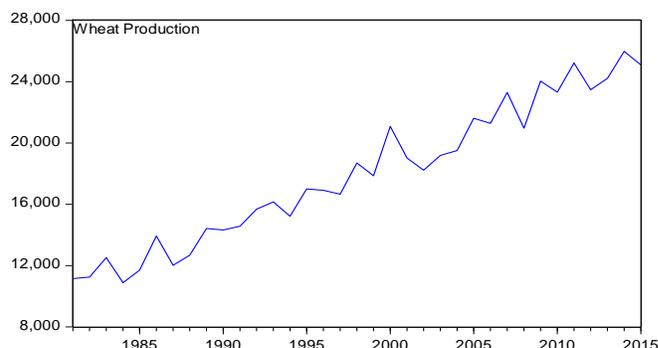


Figure 1: Wheat production in tons from 1981 to 2015.

Table 1: Data source and variables.

Variables	Formula	Measurements Unit	Source
Agriculture GDP	AGDP	Millions in PKR	PSB, WDI, SBP
Wheat Crop Yield	WCY	Yield per hectare in Kg	PSB, WDI, FBS
Area for wheat crop	AWC	'000' hectares	PSB, WDI, FBS
Fertilizers Consumption	FCON	000 nutrient tones	PSB, WDI, ok FBS, NFDC

**Model Specification:** In this study ARDL model for research employ to discover the long run and the short run nexus between predicted variable AGDP with others independent variables, such as WCY, WCA, and FCON. All the variables transformed into natural logarithm form so that heteroskedastic problem may not have faced and results implication could be generalized broadly. The model could be transcribed as presented by (Rehman *et al.*, 2017) in following way;

$$AGDP = \beta_0 + \beta_1 WCY + \beta_2 WCA + \beta_3 FCON + \mu (1)$$

In above equation.1 the simple format of equation described in which AGDP signify the agricultural group in percentage as a dependent variable, and as others indicate the wheat crop yield (WCY) in Kg/hectares, the wheat crop area identifies by WCA in the equation, whereas the last variable is fertilizers consumption for wheat crop yield.  $\beta_1, \beta_2, \beta_3$  are coefficients for variables in equation.1, and  $\beta_0$  is the intercept for model as a whole which also can identify the model accuracy. Initially, cross the stationarity level of the instrumental variables by using ADF and PP unit root test, after inspection the stationarity level of the data series, to check long-run and short run relationship by using ARDL bound testing approach. In conclusion, ARDL an econometric technique has been applied to examine impact of wheat yield crop, wheat crop area in agricultural GDP of Pakistan for encircling from 1981 to 2015.

**ARDL approach to co integration:** The ARDL bound testing model will be practice to retrieve the results from that model.

As (Pesaran *et al.*,2001) invented ARDL bound test technique for scrutiny the robustness of outcomes for short run and long run nexus. There are numerous benefits of ARDL bounds testing method; it is to be functioned irrespectively, whether the order of integration of variables is I (0) or I (1). Model application vestiges robust for a sample size that coiled for the small period, the lag modifications by model itself choice according to data series,  $\Phi$ also brings unbiased estimations for the long-run and short-run model, effective t-statistics un fluctuating in the existence of endogeneity (Mirza and Kanwal, 2017). Equation for ARDL bound testing emerged the dependent variable as  $y_t$ ,  $x_k$  referred as regressor variables, a common ARDL bound test model ( $p, q_1, \dots, q_{k1}$ ) write as in equation format:

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^p \psi_i y_{t-i} + \sum_{j=1}^k \sum_{l_j=1}^{p_j} \beta_j l_j \chi_{j,t-l_j} + \epsilon_t \quad (2)$$

In equation.2 the  $y_t$  denoted as predicted variable,  $\epsilon_t$  indicated as general originalities, coefficients of liner tendency, lags length for  $y_t$  and lags for  $k$  explanatory variables  $\chi_{j,t}$  for  $j=1$  for... $k$  respectively depicted as,  $\alpha_1 \psi_i$ , and  $\beta_j l_j$ . Additionally, let denote general lag operator as L and describe polynomial as  $\psi(L)$  and  $(L) \beta_j$ . Moreover, optimal lag length chooses on the basis of Akaike information criteria (AIC), Hannan-Quinn information criterion (HQ), Schwarz information criterion (SIC) the sequential modified likelihood ratio test (LR) and the final prediction error criteria (FPE) which is 2 for all variables.

All diagnostics test will be practiced to authenticates the model for future prediction and results stability. Test for serial correlation, LM test, Correlogram-Q test, Ramsey reset test, Jarque-Bera test for normality, heteroscedasticity test and in the end CUSUM test for coefficients stability.

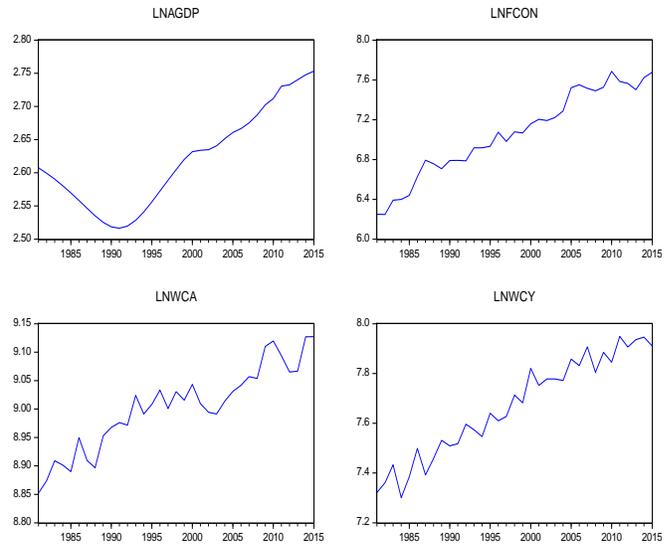
**RESULTS AND DISCUSSION**

At first hand, the time series data ranged from 1981 to 2015 gauged by employing ADF unit root test. Moreover PP unit root test also authenticated to ensure the stationarity level of data.

**Table 2: Unit Root Test.**

Variables	At Level		First Difference		Concluded Remarks
	ADF-Stat	Prob	ADF-Stat***	Order of integration	
AGDP	-3.7910**	0.030**	-1.5864	0	I (0)
WYC	-3.4359	0.061*	-11.0939***	1	I (1)
WCA	-3.7690**	0.639	-7.3035***	0	I (0)
FCON	-3.0439	0.136	-6.5980***	1	I (1)

Notes: ADF (\*) Significant at the 10% value (-2.614300); (\*\*) Significant at the 5% (-2.951125); (\*\*\*) Significant at the 1% (-3.639407). At 5% critical t values -2.8628, -2.8628 of unit root under ADF, respectively significant.



**Figure 2: Upward trend of the variables.**

Firstly, the variables are examined by using descriptive statistics test for inquiry the normality of data which shown in Table.1, the values of Jarque-Bera test and their probability is insignificant and it means that all residuals of data in appropriate form, it further also elaborates that data is ranging for 39 years and for all variables mean, median, maximum, minimum values, in addition, skewness and kurtosis for all variables depicted in the table. Graphical exhibition of variable data demonstrates that all variables are non-stationary at their levels, as it indicates an escalating trend in data series although statistically results yet not ascertained from the data. Therefore, variables are stationary while they converts into the first difference.

Assess the properties of variables such as, AGDP, WYC, WCA, and FCON by employing unit root test ADF, PP that depicted in Table.2. Empirical estimates for unit root test indicated that predicted variable AGDP at level form have a unit root that means AGDP is non-stationary at level. Results for other variables under unit root test also illustrated in the table. Furthermore, variables are capable of rejecting the null hypothesis while converts into first difference instead accept alternative hypothesis, meaning that there is no unit root in data series and all variables are stationary after a 1<sup>st</sup> disagreement.

**ARDL Bound Testing Long and Short Run Estimations:** ARDL model variables, such as CO2 emissions regressed on economic growth (GDP, GDP<sup>2</sup>), energy consumption (ECON) and electricity consumption (EPC) deeming lag 2 in the model. AIC model selection method is applied to this. F statistics is a value which pledges the cointegration presence between the variables for long run linkage. F value for the bound test, equated with bound test values which suggested by (Pesaran *et al.*, 2001). The actual values are higher than bounds test I (0) and I (1) as portrayed. Decisions are taken at

5% were under (Pesaran et al., 2001) confirmed under bound test computed. F statistics (6.4473) is higher form both bounds I(0), and I(1) lower, and upper value that point out there is long-run relationship existed between variables and speed of adjustment desirable to right the disequilibrium. Results in Table.3 for ARDL exhibited that there is positive and significant relationship existed between wheat crop area and Agricultural GDP whereas the fertilizer usage and wheat crop yield is shown in the long run and short run insignificant results.

**Table 3: ARDL Model Estimations.**

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNAGDP(-1)	1.5678	0.10306	15.2127	0.0000
LNAGDP(-2)	-0.6634	0.09393	-7.0628	0.0000
LNWCA	0.0297	0.02616	1.1363	0.2686
LNWCY	0.0019	0.01493	0.1244	0.9022
LNWCY(-1)	-0.0357	0.01463	-2.4433	0.0235
LNWCY(-2)	0.0224	0.01206	1.8612	0.0768
LNWCY(-3)	0.0101	0.01333	0.7556	0.4581
LNWCY(-4)	0.0459	0.01457	3.1540	0.0048
LNFCO	-0.0057	0.00827	-0.6876	0.4992
C	-0.3146	0.20960	-1.5010	0.1482
R-squared	0.9988	Mean dependent var		2.6226
Adjusted R <sup>2</sup>	0.9983	S.D. dependent var		0.0781
S.E. of regression	0.0032	Akaike info criterion		-8.3783
Sum squared resid	0.0002	Schwarz criterion		-7.9157
Log likelihood	139.863	Hannan-Quinn criter.		-8.2275
F-statistic	1947.01	Durbin-Watson stat		2.4711
Prob(F-statistic)	0.0000			

**Table 4: Conditional Error Correction Regression for Long run.**

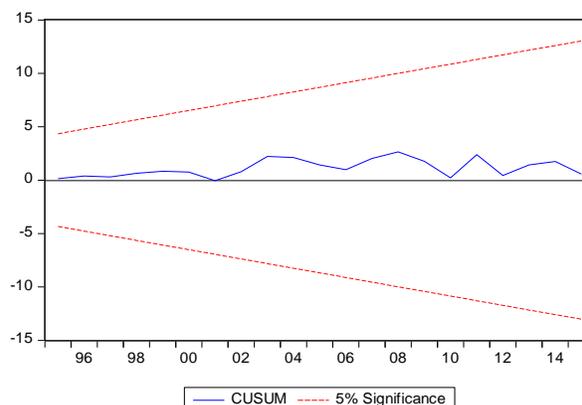
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.31461	0.20960	-1.5010	0.1482
LNAGDP(-1)*	-0.09560	0.02184	-4.3773	0.0003
LNWCA**	0.02973	0.02616	1.1363	0.2686
LNWCY(-1)	0.04458	0.01779	2.5055	0.0205
LNFCO**	-0.00569	0.00827	-0.6876	0.4992
D(LNAGDP(-1))	0.66342	0.09393	7.0628	0.0000
D(LNWCY)	0.00186	0.01493	0.1244	0.9022
D(LNWCY(-1))	-0.07847	0.02138	-3.6710	0.0014
D(LNWCY(-2))	-0.05602	0.02160	-2.5934	0.0170
D(LNWCY(-3))	-0.04594	0.01457	-3.1540	0.0048

\* p-value incompatible with t-Bounds distribution.

**Table 5: ECM Regression for short run ECM Regression.**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGDP(-1))	0.66342	0.06640	9.99073	0.0000
D(LNWCY)	0.00186	0.01040	0.17842	0.8601
D(LNWCY(-1))	-0.07847	0.01615	-4.85813	0.0001
D(LNWCY(-2))	-0.05602	0.01478	-3.79039	0.0011
D(LNWCY(-3))	-0.04594	0.01066	-4.30817	0.0003
CointEq(-1)*	-0.09560	0.01543	-6.19490	0.0000

Different diagnostic test values demonstrated that ARDL model identically full fitted model for long run as well short-run result for Pakistani wheat crops agricultural GDP. Serial correlation under correlogram with insignificant value squared correlogram negligible value, and Breusch Godfrey LM test illustrates F-statistics (2.8469) at probability values (0.0915) which denoted that residuals serially uncorrelated and normally distributed. Under the Jarque-Bera test, all the variables are typically distributed because the value for Jarque-Bera testis (0.0540) having P value (0.9733), thus arejection of null hypothesis not possible, it means that data is usually distributed. Likewise, spotted findings of heteroscedasticity test declared that data series are homoscedastic, because the Breusch-Pagan-Godfrey F-statistics (10.66451) and probability value (0.2994), cannot discard null hypothesis of homoscedasticity of variables. The practical arrangement of the model is also tested for authentication via Ramsay’s RESET test, the outcome of this test determined that the fitted values. ARDL bound testing model. The computed value of the test for t-statistics and F-statistics, 1.01376 and 1.0277 insignificant at their probability value of 0.3228. Stability test of CUSUM also authenticated the fitting states of ARDL model.



**Figure 3: Stability Coefficients CUSUM test.**

**Conclusion:** This research investigation explored the nexus between wheat crop yield, wheat crop area, fertilizers consumption for wheat and agricultural GDP in Pakistan over the period of 1981 to 2015. Data for time series retrieved from a different website such as PBS, SBP, GOP and many others sources, also Pakistan Statistical Year Book (various issues), also provides information for this research study. To cross the stationarity of the data series, ADF unit root tests were practiced. The ARDL bound testing model employed to extract the result as a whole for Pakistan. The association among wheat crop yield, the area under wheat crop, fertilizer consumption and agricultural GDP founded a long run nexus between variables in Pakistan. The results of the ARDL showed that the coefficient of wheat crop area was highly significant at 5% significance levels concerning agricultural

GDP, indicating a powerfully positive and significant relationship between these variables. But for crop wheat yield and fertilizer consumption for wheat provided insignificant results that means there is no any association between them. Finally, results suggested that in future the wheat yield crops and fertilizers usage in a way which may help to increases the GDP level for the national economic development of Pakistan.

Moreover, results may help to the Pakistani government or policymakers to concentrate on increasing the magnitude of wheat crop yield in a way that can contribute toward agricultural GDP and overall Real GDP of Pakistan. Make Tactical collation between Private landlords and government agriculture sector apprehensions to reconcile the agricultural sector for the benefit of the national welfare. Furthermore, governments have to take the solemn attentiveness towards the agriculture sector development.

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