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Agricultural Transformation and Rural Development in Pakistan A Multivariate Johansen Co-integration Analysis

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ABSTRACT

The present study has empirically examined the agricultural transformation and rural development which is relevant to Pakistan. It is two side research one side explains the agricultural transformation and the other side explains the development of rural areas of Pakistan. The time series data is used from 2000 to 2021 and employ (ADF) Augmented dickey-fuller test, Johansen Co-Integration technique, Granger causality and diagnostic tests like LM test for cereal correlation, white test for Heteroscedasticity and CUSUM test. The agricultural value added negatively affects the land under cereal production, wage and salaried workers and the rural population. Because over temperature affects cereal production which affects the wages of workers and causes unemployment in rural populations. The crop production has positively affected the wage and salaried workers, employment in agriculture and food exports because rainfall turned out the barren land into green land which lead to enhance in employment causing to increase in wages and exports of foods. A huge amount of barren land reduces the production of cereal foods and grain and the availability of green land cause to increase in this production which leads to an increase in the exports of food. The facility of electricity increases the effort, efficiency and quality of workers they take interest in their work while if they are illiterate they remain unaware of new technology and the rural areas could not develop without educated people. Cereal production could be enhanced through electricity in rural areas while if the huge amount of land is barren it may reduce the production of food grains and rural areas remain underdeveloped. We need to enhance facilities to decrease the negative and insignificant effects in rural areas and Agriculture.

Keywords: Agricultural Transformation, Rural Development, Issues and policies, Johansen Co-Integration, Granger causality, Pakistan.

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INTRODUCTION

Farming is the practice of growing crops and livestock. The history of agriculture begins thousands of years ago. After harvesting wild grain, which began at least 105,000 years ago, budding farmers began growing it around 11,500 years ago. Pigs, sheep and cattle have been domesticated for over 10,000 years. The cultivation of barley and wheat was observed in Mehrgarh in 8000-6000 BC. Along with the domestication of cattle, especially sheep and goats they grew barley, corn, emery, dates, dates, sheep, goats, and cattle. History teaches that the growth and development of agriculture are necessary to achieve generally better living conditions in all societies. This process may appear uniform on the outside but is highly variable on the inside. Pakistan is one of the world's ten largest producers of wheat, cotton, sugar cane, mangoes, dates and oranges and is ranked 10^{th} in the world in rice production. Major crops are wheat, rice, sugar cane, etc.

While the agricultural sector is the backbone of our economy, the growth of Pakistan's agricultural sector faces many challenges. Limited agricultural land, Pakistan has a total area of 79.6 million hectares, of which 30 million hectares are cultivated, indicating that more than half of the area is unused and there is huge land division and fragmentation due to modern applied farming practices. . Water detection and salinity are two problems in agriculture. Excessive irrigation or precipitation causes large amounts of water to fall on the ground; rising water levels and salinity are the results of water retention. Land scarcity means less productivity, not less land loss each year. In subsistence agriculture, farmers are connected to subsistence agriculture Most of the products consumed by farmers have houses to support large families. Thus, fewer products are available for sale. From

The Pak Rural Development Program (PRDP) is a well-established non-profit non-governmental organization (NGO) operating in the Khyber Disadvantaged Region (KDK), Punjab, Azad Jammu and Kashmir (ADK) and the Federal Tribal Administration (Brave). In October 1974, the Rural Development Administration was established under the "Ministry of Food and Agriculture". On 18 August 1979, the Rural Development Authority was transformed into the Ministry of Rural Development. The historical background of each event or program provides a source that can channel your authority to effectively influence the future. Many rural development programs have been established with the primary goal of promoting the development of rural communities.

Pakistan is an agrarian country where rural areas and people still form the backbone of the economy. Agriculture is the largest sector of the economy, providing 25% of GDP and 70% of all exports. The sector currently employs 17 million people, representing 44% of the country's workforce, with approximately 67% of the population living in rural areas or other small rural enterprises whose main source of income directly or indirectly depends on agriculture. Most of the rural poor live in areas where fertile land is scarce, agricultural potential are low, and drought and environmental degradation are common. In addition, access to basic human needs and rights such as drinking water, sanitation, education and health care is difficult in rural areas. The successful development of rural communities requires a comprehensive and inclusive approach. We must make a logical effort to look at social expectations and economic opportunities.

This study has identified the present repute of agriculture development and transformation and rural improvement in Pakistan. The actual fee of rural improvement lies within the fast transformation of the current agriculture area. It traced a few current practices and obstacles

inside the manner of affective transformation in agriculture and improvement of rural territory. Literature is filled with the content of Agriculture Development and rural development and its influence on an economy. Improvement in agricultural and rural development situation provokes high economic development while the deteriorated situation in Agriculture Development and Rural Development cause a downturn in economic growth (Ali, Aslam, & Ali 2012).

When we consider agriculture, development there arises a question is there any role of rural areas in provoking agricultural development? This question sketch and draw a scenario that which there is a need to examine the cause, effects and reasons for Agriculture Transformation and rural development (Basheer, 2014). Therefore, the researcher is trying to examine the barriers and reasons behind the low development in the agriculture sector and as in the current period the low development situation and problems/ issues that are confronted in the agricultural sector and rural areas there is needed to consider this phenomenon as a research topic.

Pakistan is a developing entity in which most of the inhabitants belong to rural areas, but prefer to access residence in urban areas (Basheer et al., 2018). Because of shortage of facilities, poverty, unemployment and many other big issues in rural areas, Therefore in this study researcher examines the rural facilities and elements of agricultural development. This topic captures great attention because Pakistan is an agricultural country and its sixty seven percent of inhabitants live in rural areas and on a world level its growth matters a lot. On the behalf of the findings of the observation of the study furnished some implications to uplift the prevailing condition of agriculture transformation device and rural improvement in Pakistan. Those implications or recommendations will help the coverage makers both at micro and macro levels to formulate proper policy professionals to design and implement effective strategies for transforming the agrarian system and improvement of rural territory in a completely smooth way. It's going to also enhance the literature on this discipline and be amenable to the researcher for destiny research programs.

Objectives of the Study

- To examine the impact of agricultural transformation and rural development.
- To know what are the main reasons behind the agriculture transformation.
- How the agricultural transformation helps the farmers in improving their financial status and also helps the farmers improve their quality of life and brings changes in the living standard of farmers.

Research Questions

- What is the nature of agricultural transformation in Pakistan?
- How does agricultural transformation improve productivity?
- What are the techniques used to disseminate the agricultural technology to the farmers in the country?
- Does the agricultural transformation affect rural development, and how?
- How does rural development improve the living standard of rural population/farmers?

- What are the barriers hindrance and factors essential for rural development, does the modern technology play an important role in the agricultural transformation and rural development yes or no?

LITERATURE REVIEW

Baig *et al.* (2010) highlighted the rural sector of Pakistan. They examined the management of rural development. They proposed about Pakistan's agricultural based economy and rural development depend upon agriculture. Pakistan has self-sufficiency in its major crops. The contribution of agriculture to GDP has been great but stop or skewed recent years we can say downward trend. They told us the country has self-sufficiency in the cultivation of cotton and rice and also enjoyed monopolies in the international markets and economies. Although, the fruits, mangoes, and citrus meat the world quality standard. But unfortunately, the country has not paid even self-sufficiency in the agriculture sector.

Hussain *et al.* (2011) observed oversees the rice growing district and the Punjab hybrid district in Pakistan. Six regions have been selected to address the challenges of income generation, poverty and crop production in Pakistan. There have been selected three districts from the wheat rice zone (Sialkot, Gujranwala and Sheikpura and three districts from Faisalabad, It shows that crop yields account for about two-thirds of farm household income. It is estimated that 34% and 28% of those involved in agriculture are poor in mixed crop areas and wheat rice. The peasant poverty index is 0.41 and 0.14. Income inequality was higher in mixed growing regions than in rice and wheat regions, and rural poverty was higher in the mixed growing region showing that crop yields account for about two-thirds of farm household income (Basheer et al., 2021). It is estimated that 34% and 28% of those involved in agriculture are poor in mixed crop areas and wheat rice. The peasant poverty index is 0.41 and 0.14. Income inequality was higher in mixed growing regions than in rice and wheat regions, and rural poverty was higher in mixed growing regions.

Onyegi *et al.* (2012) presented the statistical results of a study of factors that can help to explain the level of access to electricity in developing countries. It focused on why SSA countries are lagging in the provision of electricity services despite reforms in the electricity sector. Poverty, gross domestic savings, energy-related total fixed investment, rural population, and population density were used as independent variables in the econometric analysis. We found that some of the factors that characterize access to electricity in SSA countries have a different influence than in other emerging markets. Our results show that the rural population plays a more important role in SSA than in non-SSA countries. In addition, government efficiency seems to explain the greater variability in SSA performance levels than in non-SSA countries. He stressed the need for clear political commitment and leadership to provide electricity to the rural poor.

Ullah (2013) studied the impact of agricultural transformation on rural development in Pakistan. Existing theories of agricultural transformation and rural development are used, indicators are developed and empirical research was conducted using time series tools. Time series data used from 1981 to 2001 showed that collaborative integration methods and error correction model (ECM) approaches have a positive and significant impact on rural development, where agricultural transformation uses the agricultural sector. High

standard of living through the transformation of agriculture was revealed by Ali, Faridi, & Ali (2013).

Elahi, *et al.* (2015) examined the impact of balance and imbalance on fertilizer users was investigated using stochastic production limits and baseline data. Primary data was collected from the Multan region, a cotton and wheat producing region in Punjab. The average technical efficiency of balance users of fertilizers was indicated. It was also highlighted that to obtain high efficient crop the proper requirements were plant, fertilizers and education extension services, etc.

Touzard and Labarthe (2016) proposed a new research agenda and discuss the regulation theory in terms of agriculture transformation. It has consisted of two parts, in the first part they examined research findings that exist in theory. This theory focused on the crisis and emergence of the economic regime of agriculture in industrialized countries (Basheer et al., 2019). The second part showed how this body of researchers observed the different dimensions of transformations in agriculture and progressively combined them with other research programs.

Azam (2017) proposed to study the agricultural sector of Pakistan and also study its impact on the economy. Agricultural problems and possible solutions are shown. In this study, data was collected from various reports, articles, and websites, and time series data was used. Primary and secondary crops are fishing, forestry, fruits and livestock and some problems such as water shortage, natural disasters, mismanagement and many other problems are negatively affecting Pakistani agriculture. This problem has slowed down economic growth and production in Pakistan's agricultural sector.

Masood *et al.* (2018) observed and used different methods and models. It was designed to forecast wheat production based on time series data and uses the best time series models. A researcher wants to forecast wheat production for 2017-18, 2018-19 and 2019-20 using time series data from 1971-72 to 2016-17. For wheat production, linear, quadratic, exponential, S-curve, double exponential smoothing, single exponential smoothing, creeping average, and ARIMA were evaluated. ARIMA (2, 1, 2) and quadratic models are used, which are preferred for predicting wheat yields.

Shafique *et al.* (2019) proposed to study the contribution of LOT technology to the minimization of rural poverty associated with agriculture and necessary in rural areas. It is based on LOT technology. It is important in the fields of irrigation, fertilization, disease control and weather control. However, Pakistan's agriculture has not undergone such changes as transportation, education, water supply, health care and many other issues have become major obstacles to rural development.

Babar *et al.* (2020) highlighted approximately transgenic plants and food for the development of agriculture. Researchers changed into also located that transgenic technology has been used for you to improve the crop yields first-rate and portions. There has been also involved numerous danger as a way of cultivating transgenic plants. The studies work on genetically modified organisms (GMO) development and their overall performance observed to function as a guide for scientists to assist them to select useful genes for crop transformation in Pakistan.

Chandio *et al.* (2021) examined the impact of world trade on grain production in Pakistan between 1977 and 2014 in terms of weather conditions (CO2 emissions), economic improvements and technological advances (fertilizer use and modern seed distribution). The observers implemented the Deviation Delayed Autoregressive (ARDL) boundary control approach to the analysis of the relationship of many variables over a long period. The results of the ARDL limit test method confirm the long-term existence that most variables approach. Empirical effects showed that CO2 emissions have a negative impact on crop production in the short and long term. Yields declined as weather conditions approach a boom in international trade. The results also confirm that economic development has a positive effect on grain production in both cases.

3. Methodology and Statistical Results

The eleven variables are Agriculture value added (AVA), Land under cereal production (LUCP), Wage and salaried workers (WSWOR), Rural population (RP), Crop production index (CPI), Employment in agriculture (EIA), Food exports (FDEXP), Primary education (PRIEDU), Access to Electricity Rural (AER), Cereal production (CRLPRO) and Agricultural land (AGRIL) of this analysis which is mentioned in the theoretic and verifiable phase. The data has been collected for the explanatory variables from world development indicators (WDI) and the evidence mark from WDI 2022 online from the official website with annual frequency from the previous 2000 to 2021. To measure or estimate the agricultural and rural development researcher develop the following five models of Agriculture Development and rural development and these models are discussed below.

$$AVA_t = \beta_{0t} - \beta_1 Lucp_t - \beta_2 Wswor_t - \beta_3 Rp_c + e_t \quad (3.1)$$

This is the model of Agriculture Development in which the agriculture value added negatively affects the land under cereal production, wage and salaried workers and rural population. Because over temperature affects cereal production which affects the wages of workers and causes unemployment in rural populations.

$$Cpi_t = \beta_{0t} + \beta_1 Wswor_t + \beta_2 Eia_t + \beta_3 Fdexp_t + e_t \quad (3.2)$$

In this model of Agriculture Development the crop production has positively affected the wage and salaried workers, employment in agriculture and food exports because rainfall turned out the barren land into green land which lead to enhance in employment causing to increase in wages and exports of foods.

$$Fdexp_t = \beta_{0t} - \beta_1 Agril_t + \beta_2 Lucp_t - \beta_3 Crlpro_t + e_t \quad (3.3)$$

In this model, a huge amount of barren land reduces the production of cereal foods and grain and the availability of green land cause to increase in this production which leads to an increase in the exports of food.

$$Rp_t = \beta_{0t} + \beta_1 Wswort - \beta_2 Priedu_t + \beta_3 Aer_t + e_t \quad (3.4)$$

In this model of rural development the facility of electricity increases the effort, efficiency and quality of workers they take interest in their work while if they are illiterate they remain unaware of new technology and the rural areas could not develop without educated people.

$$Rp_t = \beta_{0t} - \beta_1 Lucp_t + \beta 2 Crlprot + \beta 3 Aert + e_t \quad (3.5)$$

Cereal production could be enhanced through electricity in rural areas while if the huge amount of land is barren it may reduce the production of food grains and rural areas remain underdeveloped.

DATA SOURCE

This analysis will be carry-out through time series analysis and it is based on secondary data. In this research data is gathered for the period of 2000-2021which is the current time period. Data has been obtained from the source of world development Indicators (WDI). To examine the upper given models the researcher employed the Descriptive statistics, Correlation Analysis, ADF Unit root, Johansen Co-integration technique, Granger causality and then diagnostics checking including CUSUM test, serial correlation LM test and the white test of Heteroscedasticity has been employed.

Table 1: Descriptive Analysis

	Mean	**Median**	**Maximum**	**Minimum**	**Std, Dev**	**Skewness**	**Kurtosis**
AVA	23.2081	23.0729	25.6172	21.6079	0.9623	0.7184	3.6094
LUCP	13241	13348	14087	12022	62853	-0.4365	1.9962
RP	1.8842	1.8633	2.3509	1.5685	0.1963	0.5205	2.9090
WSWOR	39.1700	38.6600	43.6800	35.5800	2.4473	0.5337	2.3897
PRIEDU	186975	181630	235879	139871	301743	0.1791	2.0552
AER	57.2108	57.3068	58.8352	54.2074	1.2121	0.5398	2.7116
CPI	91.4995	93.8100	106.7800	70.4600	11.5708	0.3983	1.9275
EIA	41 6850	42.5900	44.7000	36.9200	2.3933	1.1355	2.8620
FDEXP	16.1372	17.6523	20.8398	10.4209	3.9706	0.3931	1.4313
CRLPRO	369660	373217	442999	270480	568394	0.3568	1.8188
AGRIL	47.0481	47.0449	48.0010	45.7166	0.6824	0.5190	2.5187

Note: Source Author own, s calculation using e views 9

This table shows that the average value of AVA is 23.2081. The average increased from a minimum value of 21.6079 to the maximum value of 25.6172 the value of skewness is 0.7184 and the value of kurtosis for average is 3.6094. The average value of other variables and the value of skewness and kurtosis have been also displayed in the above exhibited table.

To examine the correlation impact on variables with each other utilizing the correlation method in eviews which has been displayed with the help of the above displayed table. It is required that in correlation analysis each variable correlation with itself should be one or diagonal which shows that the variable has the perfect relationship. For further explanation, in the above stable, AVA has a perfect correlation with itself as its effect on itself is one and the other variables have also the same effect on itself.

Table 2: Correlation Analysis

	AVA	LUCP	RP	WSWOR	PRIEDU	AER	CPI	EIA	FDEXP	CRLPRO	AGRIL
AVA	1.0000										
LUCP	-0.1601	1.0000									
RP	0.3205	-0.8002	1.0000								
WSWOR	-0.4501	0.4722	-0.7636	1.0000							
PRIEDU	0.3469	0.8567	-0.9320	0.7656	1.0000						
AER	-0.0892	0.6213	0.4742	-0.0238	-0.3886	1.0000					
CPI	-0.2026	0.9382	-0.9020	0.6301	0.9364	0.5905	1.0000				
EIA	0.2241	0.4673	0.6824	-0.9031	-0.7736	0.0609	0.6036	1.0000			
FDEXP	-0.0156	0.8666	-0.8674	0.5353	0.8433	0.5897	0.9191	0.5295	1.0000		
CRLPRO	-0.1468	0.9427	-0.9010	0.6265	0.9269	0.6051	0.9907	0.6124	0.9164	1.0000	
AGRIL	0.1436	-0.1476	0.0479	0.3750	0.0165	0.1613	0.0611	0.4407	0.1430	0.0230	1.0000

Note: Author own, s calculation using an e views 9

This table shows the stationary variables. The Ava is the unit root at the level and intercept and the probability value is (0.0287). The Ava also unit root at 1st difference and intercept and its probability value is (0.0008) and also unit root on trend and intercept and the probability value is (0.0086) and the whole variables also stationary or unit root at 1st difference and the probability value of intercept and trend and intercept has been also displayed.

Table 3: Unit Root Analysis

Variable name	**Level**		**1st difference**		**Decision**
	Intercept	**Trend and intercept**	**Intercept**	**Trend and intercept**	
AVA	-3.2879	-3.0890	-4.9671	-4.7947	I (1)
	(0.0287)	(0.1341)	(0.0008)	(0.0086)	
LUCP	-1.1786	-2.4856	-4.6096	-4.5757	I (1)
	(0.6634)	(0.3307)	(0.0018)	(0.0086)	
RP	-2.2621	-4.1721	-3.2687	-3.6818	I (1)
	(0.1930)	(0.0189)	(0.0344)	(0.0545)	
WSWOR	0.9449	-1.1025	-5.9111	-3.0656	I (1)
	(0.9938)	(0.9016)	(0.0001)	(0.1432)	
PRIEDU	-0.4738	-1.9599	-4.8939	-4.7486	I (1)
	(0.8781)	(0.5884)	(0,0010)	(0.0061)	
AER	-1.8444	1.6951	-4.4481	-0.1936	I (1)
	(0.3502)	(1.0000)	(0.0026)	(0.9864)	
CPI	-1.4145	-3.2303	-6.7636	-6.7553	I (1)
	(0,5545)	(0.1055)	(0.0000)	(0.0001)	
EIA	0.1277	-1.2112	-4.2170	-3.2668	I (1)
	(0.9602)	(0.8815)	(0.0042)	(0.1052	
FDEXP	-1.1194	-2.6486	-6.8760	-4.6321	I (1)
	(0.6868)	(0.2648)	(0.0000)	(0.0083	
CRLPRO	-1.2133-	-1.3512	-8.8460	-8.8122	I (1)
	(0.6473)	(0.8436)	(0.0000)	(0.0000)	
AGRIL	-1.7149	-1.7040	-8.8122	-4.6757	I (1)
	(0.4097)	(0.7132)	(0.0022)	(0.0071)	

Note: Source: Author own, s calculation using e views 9

In the table below of lag length selection criteria, the combined results of five models are presented. For this purpose, we use various lag order selection criteria and the results are presented in Table 5.4. There are three lags used and shown in the table above, these values are denoted by different names such as LR, FPE, AIC, SC and HQ, delay values are {}, delay values are 2, 3 delays in The value is in (). Here are some criteria to help you choose the right delay length. For example, the Schwartz information criterion, the Akaike information criterion, and the Hanan-Qain information criterion are the particular estimation criteria. Use this criterion to determine the latency of each model across all of these models

Table 4: Lag Length Criteria

	Model 1	Model 2	Model 3	Model 4	Model 5
LogL	{-328.0092}	{-172.8722}	{-356.6349}	{-604.6429}	{-664.8058}
	[-271.6844]	[-130.7906]	[290.1095]	[-554.0028]	[-627.4919]
	(-252.7976)	(-111.8316)	(-256.6481)	(-525.9099)	(-605.8720)
LR	{NA}	{NA}	{NA}	{NA}	{NA}
	[84.4872*]	[63.1223*]	[99.7881]	[75.9600]	[55.9708*]
	(20.7754)	(20.8549)	(36.8075*)	(30.9021*)	(23.7819)
FPE	{3.08e+09}	{564.5575}	{5.40e+10}	{3.19e+21}	{1.31e+24}
	[57095274]	[43.41714]	[3.60e*08]	[1.04e+20]	[1.62e+23]
	(54073695*)	(40.82315*)	{79471192*)	(3.93e+19*)	(1.17e+23*)
AIC	{33.2009}	{17.6872}	{36.0634}	{60.8642}	{66.8805}
	[29.1684]	[15.0790]	[31.0109]	[57.4002]	[64.7491]
	(28.8797*)	(14.7831*)	(29.2648*)	(56.1909*)	(64.1872*)
SC	{33.4000}	{17.8863}	{36.2626}	{61.0634}	{67.0797}
	[30.1641*]	[16.0747*]	[32.0066]	[58.3960]	[65.7449*]
	(30.6720)	(16.5754)	(31.0571*)	(57.9833*)	(65.9795)
HQ	{33.2398}	{17.7260}	{36.1023}	{60.9031}	{66.9194}
	[29.3628]	[15.2734]	[31.2053]	[57.5946]	[64.9435]
	(29.2296*)	(15.1330*)	(29.6146*)	(56.5408*)	(64.5370*)

Note: Lag order selection by the criterion like LR, FPE, AIC, SC and HQ, value in {} is of Lag 1, value in [] is of Lag 2 and value in () is of lag 3. Source: Author own, s calculation using a reviews 9

Table 5: Unrestricted co-integration rank test (Trace)

Hypothesized no. of CE(S)	Model-1	Model-2	Model-3	Model-4	Model-5
None*	0.9795	0.9823	0.9960	0.9937	0.8128
	{130.9437}	{111.2179}	{105.3706}	{160.4952}	{72.79308}
	[54.0790]	[54.0790]	[28.5880]	[54.0790]	[54.0790]
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0005)
At most 1*	0.7489	0.3578	0.9667	0.8278	0.6262
	{56.9957}	{11.0595}	{101.6102}	{64.1425}	{40.9555}
	[35.1927]	[20.2618]	[35.1927]	[35.1927]	[35.1927]
	(0.0001)	(0.5364)	(0.0000)	(0.0000)	(0.0107)
At most 2*	0.6389	0.3578	0.8008	0.7755	0.4798
	{30.7346}	{11.0595}	{36.9200}	{30.7123}	{22.2577}
	[20.2618]	[20.2618]	[20.2618]	[20.2618]	[20.2618]
	(0.0013)	(0.5364)	(0.0001)	(0.0013}	(0.0262)
At most 3*	0.4506	0.1298	0.2805	0.1151	0.4042
	{11.3808}	{2.6429}	{6.2566}	{2.3249}	{9.8393}
	[9.1645]	[9.1645]	[9.1645]	[9.1845]	[9.1645]
	(0.0187)	(0.6493)	(0.1718)	(0.7125)	(0.0372)

Note: First displayed value is of coefficient, Value in {} is of trace statistic, value in [] is of 0.05 critical value, value in () is of probability. Source: Researcher own, s calculation using an eviews 9

In the above displayed table, the researcher applied Johansen co-integration test The trace static values which are mentioned in the above table and have been described in different brackets like trace static is in {} bracket, 0.05 critical value is in [] bracket, the value of probability is in () bracket and the eigenvalue is open shows that there are four co-integrated equations which are (None*, At most 1*, At most 2* and At most 3* at 0.05% level of significance. The (*) star shows the rejection of the null hypothesis, (no co-integration among the variables) at a 0.05 % level of significance. The table also explored that there is co-integration among the variables of the study.

Table 6: Unrestricted co-integration rank test (Eigenvalue)

Hypothesized no. of CE(S)	**Model-1**	**Model-2**	**Model-3**	**Model-4**	**Model-5**
None*	0.9795 {73.9479} [28.5880] (0.0000)	0.9960 {105.3706} [28.5880] (0.0000)	0.9960 {105.3706} [28.5880] (0.0000)	0.9937 {96.3526} [28.5880] (0.0000)	0.8128 {31.8375} [28.5880] (0.0185)
At most 1*	0.7489 {26.2610} [22.2996] (0.0133)	0.7085 {23.4243} [22.2926] (0.0347)	0.9667 {64.6901} [22.2996] (0.0000)	0.8278 {33.4301} [22.2996] (0.0010)	0.6262 {18.6977} [22.2996] (0.1478)
At most 2*	0.6389 {19.3537} [15.8921] (0.0137)	0.3578 {8.4166} [15.8921] (0.4988)	0.8008 {30.6634} [15.8921] (0.0001)	0.7755 {28.3873} [15.8921] (0.0003}	0.4798 {12.4184} [15.8921] (0.1630)
At most 3*	0.4506 {11.3808} [9.1645] (0.0187)	0.1298 {2.6429} [9.1645] (0.6493)	0.2805 {6.2566} [9.1645] (0.1718)	0.11517 {2.3249} [9.1645] (0.7125)	0.4042 {9.8393} [9.1645] (0.0372)

Note: First displayed value is of coefficient, value in {} is of maxeigan value, value in [] is of 0.05 critical value and value in () is of probability value. Source: Author own, s calculation using an e views 9

In the above displayed table, the researcher applied Johansen co-integration test. The eigenvalues values which are mentioned in the above table and have been described in different brackets like max eigenvalue is in {} bracket, 0.05 critical value is in [] bracket, the value of probability is in () bracket and the eigenvalue is open shows that there are four co-integrated equations which are (None*, At most 1*, At most 2* and At most 3* at 0.05% level of significance.The sign of static shows the null hypothesis rejection, (no co-integration among the variables) at a 0.05 % level of significance. The table also explored that there is co-integration among the variables of the study.

In the above exhibited table the combined long run results of five models are presented and six columns existed here. According to the normalized coefficients, the land under cereal production, the wage and salaried workers and the rural population have negatively and significantly affected the agriculture value added when common agricultural policy which should stabilize farm income and make agriculture business more viable and sustainable so these areas facing natural constraints (Jan, et al., 2019). The unequal income distribution

is a more important element to make negative effects of wage and salaried workers on agriculture value added. Chandio, *et al. (*2019); *Soukupova, et al. (*2019); Berry, *(*1972); and Mustafa, *et al. (*2013) found a negative association between all these variables of the model.

Table 7: Long Run

Variables	**MODEL 1**	**MODEL 2**	**MODEL 2**	**MODEL 4**	**MODEL 5**
AVA (-1)	1.0000	…..	…..		
LUCP (-1)	6.69E-07 (1.5E-07) [4.5806]	…..	…..	-9.43E-08 (2.0E-08) [4.7151]	-8.20E-06 (4.1E-06) [-2.0172]
WSWOR (-1)	0.8511 (0.03649) [23.3294]	- 26.34629 (1.43027) [- 18.4205]	-- 0.039582 (0.00364) [- 10.8869]		
RP (-1)	13.7124 (0.6815) [20.1205]	…..	1.0000	1.0000	2.12E-07 (4.2E-07) [0.5031]
CPI (-1)	…..	1.0000	…..		
EIA I (-1)	…..	-30.4897 (1.5374) [- 19.8321]	…..		
FDEXP (-1)	…..	-0.3483 (0.1634) [-2.1319]	…..		1.0000
PRIEDU (-1)	…..	…..	3.06E-08 (4.2E-09) [7.2653]		
AER (-1)	…..	…..	-0.0640 (0.0053) [- 11.9057]	-0.1205 (0.0063) [- 19.0620]	
CRLPRO (-1)	…..	…..	…..	-1.47E-08 (2.2E-09) [-6.7959]	
AGRIL (-1)	…..	…..	…..		4.3828 (0.8997) [4.8714]
C	-89.3272 (4.0043) [- 22.3078]	2201.525 (119.141) [18.4782]	2.7825 (0.2703) [10.2939]	4.3520 (0.4975) [8.7466]	124.1833 (57.9182) [-2.1441]

Note: First displayed value is of coefficient, value in () is std. Deviation and value in [] are t-statics

In the second model, there is a positive association between employment in agriculture, wage and salaried workers, food exports and crop production as we show that growing a variety of crops also contributes to more agricultural work leading to an increase in employment in the agricultural sector in rural areas. Higher crop diversity is also consistent with higher yields and is not associated with changes in socioeconomic development and economic growth. The authors note that unemployment in rural areas is being sucked into other sectors of the economy, and unemployment is a major problem affecting livelihoods. The effects of the human capital on household income are partially realized through the reallocation of labor from lower productivity activities to higher productivity activities. Feder (1985); Behrman, *et al.* (1997); Lamb (2000); and Garibaldi, *et al*. (2019) found a positive association between the variables.

There are negative effects on agricultural land, positive of land under cereal production and negative of cereal production on food exports. Different levels of economic development, agricultural employment, agricultural subsidies and consumer agriculture. Food improves livelihoods, along with abundance and diversification of farmland and exports reduce that livelihood and lead to a shortage in the domestic food supply (Bojnec, *et al.* 2017; and Angus, *et al. (*2009). The share of agricultural exports and food exports to the total exports greatly influenced the agricultural land expansion or positively influenced the land which is under the production of cereal foods or grain yields and also climate changes influenced in the long run. Lee (2009) has also found these results. The major increase in consumption of meat or cereal food and cereal production will lead to an animal production system based on crop livestock and an industrialized system in the developing world. Bojnec *et al. (*2017); Angus *et al. (*2009); and Hong Yang *et al. (*2007) found a negative relationship between the variables.

There is a positive relationship between workers and rural residents and access to electricity and primary education are influenced negatively. It has long been assumed that non-profit programs can affect the wage balance. 70% of the world's 1.4 billion poor live in rural areas (IFAD, 2011). Some of them were farmers who cultivated their land, but some workers did not have land at the base of the pyramid. It is supported by agricultural workers on an irregular basis. (ILO, 1996 and Rosenzweig, 1978). The long-term effects of primary school scholarship programs have been shown to ignore the effects on school attendance, household spending, calorie expenditure, and protein intake. (Alexandre Simons *et al.* 2022) has also found these results. The access of the rural population to electricity has a positive and significant effect on economic growth. A lack of access to energy or electricity is a less obvious manifestation of poverty. Most the developing countries of the world include rural electrification programs in their effort to improve social conditions. (Rehman *et al.*2018) also found a positive association between the rural population and access to electricity.

An increase in the temperature leads to a reduction in cereal production and food security which leads to low income for rural farmers or population and therefore, the living standard of the rural population adversely and negatively affects the rural population. Kumar *et al. (*2021) and warsame *et al.* (2021) found a negative association. There is a positive association between cereal production and rural population. If the atmosphere and climate change are suitable it leads to normalize the temperature and weather leads to increased cereal production Chandio *et al. (*2021) also found these results. Rural Access to electricity has a positive and significant impact on economic growth. If the rural population has more

access to get the facility of electricity they could enhance their working efficiencies and cultivate more crops (Onyegi *et al.*2012) also found a positive correlation between access to electricity and the rural population.

In the last row of the above displayed long run table, the values of the constant term are displayed. In this row first displayed value is of coefficient, value in ( ) is std. Deviation and value in [ ] are t-statics, but just the value of coefficient considered here to test the fitness of the model.

Table 8: Short Run

Variables	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
D(AVA)	-0.8620 (0.2687) [-3.2074]	…..	…..	…..	…..
D(LUCP)	-11245.86 (152505.) [-0.0737]	…..	…..	-133719.0 (962093.) [-0.1389]	-28072.24 (25600.4) [-1.0965]
D(WSWOR)	0.5638 (0.4487) [1.2564]	-1.8253 (3.6052) [-0.5063]	-133719.0 (962093.) [-0.1389]	…..	…..
D(RP)	-0.0171 (0.0115) [-1.4895]	…..	-0.2344 (0.0275) [-8.5230]	-0.2643 (0.0259) [-10.2073]	…..
D (CPI)	…..	-0.1793 (0.0863) [-2.0776]	…..	…..	…..
D (EIA)	…..	-0.0552 (0.0170) [-3.2478]	…..	…..	…..
D (FDEXP)	…..	-0.0559 (0.0471) [-1.1875]	-0.0559 (0.0471) [-1.1875]	…..	-0.3641 (0.1204) [-3.0234]
D (PRIEDU)	…..	…..	-1.8253 (3.6052) [-0.5063]	…..	…..
D (AER)	…..	…..	…..	-2.8244 (2.7851) [-1.0141]	…..
D (CRLPRO)	…..	…..	…..	4401741. (53334) [0.8253]	-365652.9 (169205.) [-2.1610]
D (AGRIL)	…..	…..	…..	…..	-0.0248 (0.0459) [-0.5397]

Note: First displayed value is of coefficient, value in () is std. Deviation and value in [] is t-statics
Source: Author own, s calculation using an e views 9

There is a negative and insignificant association between variables in the short run because of the limited cultivatable and barren or damaged land area on which cultivates the cereal crops in Pakistan. To convert the barren land into green land too much time is required therefore, the land remains shortfall and has negative effects in the short run. The wage and salaried workers and Agriculture value added has a negative association because the labor is not fully mobile in the short run. (Chandio *et al.*2019), Nugroho *et al.* 2021) and (Mustafa *et al.* 2013) also found these results. because minimum labor in the short run because they

demand higher wages and the owners do not pay higher wages therefore, the strength of workers remains low in the short run.

In the second model, the analysis indicates that the excess real wages play an important role in the short run. Higher wages build up the interest of farmers in their work and therefore production of crops increases. The higher wages and higher labor supply increase the employment in agriculture especially among Pakistani smallholders because the increase in employment leads to an increase in the production of crops. Meals and export crops are substitutes in manufacturing in the short run. Total agricultural output positively responds to the boom in food fees but negatively replies to will increase in export charges in the fast run. As farmers shift assets to export vegetation manufacturing they earn greater income or earnings but a shortfall in home meals deliver due to exportation (Lamb, 2000; Chandio *et al.*2020; and Klein, 2012).

The abundance of agricultural land and export diversification reduces livelihood, especially in rural areas of Pakistan. (Bojnec, 2017) found the negative association between food exports and agricultural land. The share of agricultural or food exports to the total exports greatly influenced the agricultural land expansion which is under the production of cereal food or grain yield in the short run. The land under cereal production or export of food and crops positively correlated to each other in the short run (Barbier, 2004) found a positive association. As the farmers' reallocation, the resources into the export of food, the domestic food supply remains short fall, therefore, the cereal production negatively affects the food exports. (Khan *et al.* 2020) also found a negative association between cereal production and food exports.

The land, labor and capital are fixed in the short term. With rural unemployment rates being strict the short term migrants have become important in rural areas of Pakistan. Distribution of jobs is an important determinant as well as higher wages of migrants therefore; wage workers and rural population have a positive association. Agrawal *et. al. (*2015) found the positive association between rural population and wage and salaried workers. The literacy rate of Pakistan in (2019) was around 58 percent with less than 46.49 percent of women being illiterate and more than 69.29 percent of men in Pakistani schools being found in rural Pakistan this made it much harder for students to get an education in Pakistan. (Chandrasekhar *et al.* 2015) found a negative association between the rural population and primary education. Access to electricity rural (percentage of rural population) in Pakistan was reported at 58.66 percent in 2019 (World Development Indicator). The greater the electricity provide to rural areas, the faster the growth and development will be (Ali, Chaudhary, & Ali 2015; and Valkert *et al.* 2016; Rehman *et al.* 2018; and Lewis *et al.* 2020).

When the temperature increases it demonstrates a reduction in cereal production. A huge amount of barren land in rural areas of Pakistan negatively affects cereal production therefore; it may lead to reducing the employment of rural people which leads to reducing the incomes which they could earn from that land. Chandio *et al. (*2020) found the negative association between rural population and land under cereal production. The weather or rainfall has positively affected cereal production (Chandio *et al.* 2022). Electricity is essential for social and economic development. Rural electrification can be a motive for structural transformation in rural regions within a brief time frame and rural populace benefit facilities and the interest of rural hard work could be superior to their work. There

is a positive association between access to electricity in rural and rural populations. (Mulder, *et al.* 2008) found these results.

CONCLUSION

This chapter reflects the overall picture of the study and highlights the summary of findings of the models which the author resulted and displayed in this thesis. The time series data analysis evaluates the linear analysis of agricultural transformation and rural development in Pakistan. To bring the improvement in the agricultural sector and enhance the productivity in this sector along with the development of rural areas the author presented some suggestions and policy implications which were taken into account based on the study. In some models, the agricultural transformation and rural development have a positive association while in some models it has a negative association with each other.
This study consists of an empirical investigation of the agricultural transformation and rural development in Pakistan. Time series analysis was carried out for this study and it was based on secondary data for the period of (2000-2021). The data for this analysis was obtained from the world development indicator in the form of a percentage. To find empirical results ADF (augmented dickey-fuller), Johansen co-integration technique, Granger causality and diagnostics test included LM test for cereal correlation White test for heteroscedasticity and CUSUM test was applied in this research. The author has included the variables to analyze the empirical findings discussed below

POLICY IMPLICATIONS

To bring the improvement and development in the agriculture sector and rural areas of Pakistan the author presents some suggestions or policy implications:

- The land which has been declared useless due to water-logging and salinity, tube wells should be installed in the affected areas and the land can bring under cereal production. These measures should be taken on a priority basis to avoid further deterioration of land.
- The major problem of agriculture in Pakistan is the scarcity of water, most of the land is living unused due to this problem. Therefore the irrigation facilities must be extended to increase the output productivity.
- Due to poverty and illiteracy, our farmers hesitate to purchase fertilizers. There should be an increasing trend of primary education in rural areas that our farmers could easily and freely purchase fertilizers.
- The farmers should be provided better quality seeds at the lowest price and right time. Better seeds will ultimately give a better yield of cereal crops and production. The government has extended the existing credit facility to a large extent.
- Increase of literacy rate in rural areas especially in Agriculture Education is the need of the time, the more educated the farmers will be the better will be the results achieved and stipend programs for primary and secondary students should be increased to increase education in rural areas.
- Most of the villages in Pakistan lack even basic amenities of life. This results in brain drain from villages to cities. If the facility of electricity was properly provided in rural areas the talented people had trained themselves, their contribution to agriculture would have been far greater

- The rural areas of Pakistan must be provided with roads and infrastructure with marketing centers and better means for transportation and communication should be provided to achieve the development in the agriculture sector and rural areas of Pakistan.

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