



## **Agricultural Land Expansion and Food Security in Pakistan: An Empirical Analysis**

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### **Abstract**

*This study empirically investigates the impact of agricultural land, urbanization, GDP, food import, and credit to agricultural sector on food security in Pakistan. The study employs Auto Regressive Distributive Lag Model (ARDL) bound testing procedure to estimate the impact of these factors on food security from the period 1990 to 2016. Following the literature, we have employed two dimensions of food security: food availability and food accessibility. Food availability is measured by food supply (kcal/capita/day) while food accessibility is measured by food price indices. The results indicate that agricultural land, GDP growth, and credit to agricultural sector have positive and increase in urban population have negative impact on both dimensions of food security however, food imports have positive impact on food availability and negative on food accessibility in the country.*

**Keywords:** Food security, food availability, food accessibility, agricultural land

### **1 Introduction**

For national security, food security is very essential. It generally ignores (Fullbrook, 2010). Globally 800 million people suffer hunger and the majority of people live in developing countries. According to the Global Hunger Index in 2018 out of 109 qualifying countries, Pakistan is in the 106<sup>th</sup> position with a score of 32.6 that is a serious level of hunger. Less than or equal to 9.9 scores is considered low, 10.0 to 19.9 moderate, 20.0 - 34.9 serious, 35.0 to 49.9 score alarming, and  $\geq 50$  is extremely alarming. Following Figure 1 shows the Global Hunger Index scores and level of hunger changing from 2000 to 2018.

According to the world food program 2018, national nutrition survey, in Pakistan, 60 % of the population faces food insecurity. On average they spend 50.8 % of their monthly income on food. Most of the poor people for their livelihood depend on agriculture. Therefore, the land is an important factor of production. Food security is a very serious issue all over the world including Pakistan. In a situation when food supply covers the demand of population in the country, then it's called food secured country, on the other hand when food supply does not fulfill the demand of its population, it is called food unsecured country. When food supply in a country covers the demand

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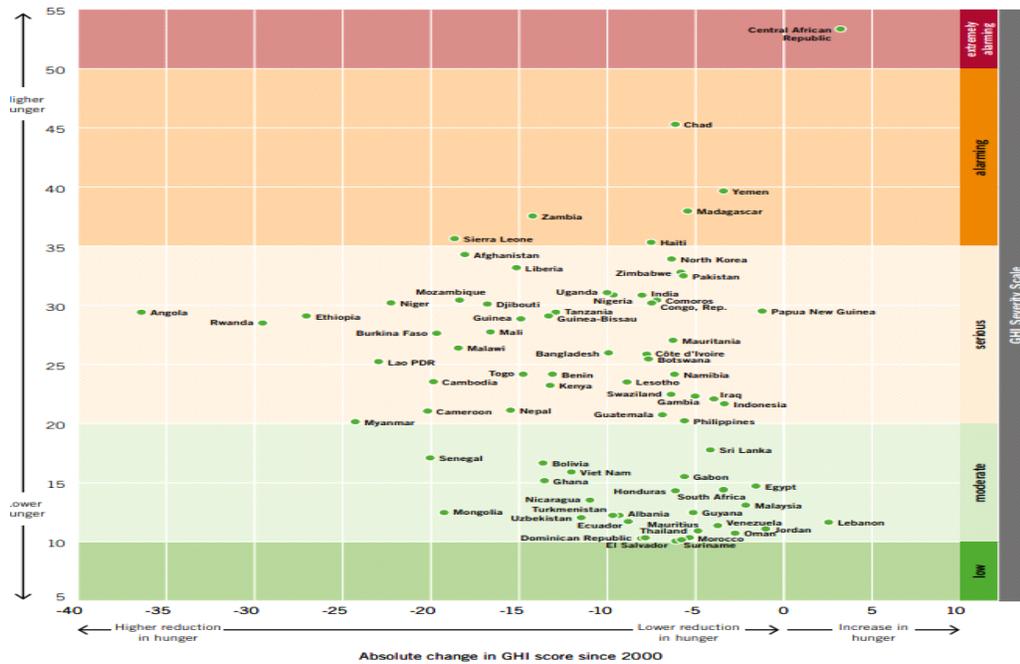
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of its population for foodstuff this situation is a food secure country. On the other hand, food insecurity exists when the food supply does not fulfill the foodstuff demand of its population.

**Figure 1**  
*GHI Scores and Progress since 2000*



Due to infrastructure, climatic and economic factors, scarcity in food-producing is the general thing (Fullbrook, 2010). In Pakistan overtime average per capita caloric consumption is declining, despite increasing per capita dietary energy supply (Ahmad, Iqbal, & Farooq, 2015). The rise in food prices is a very alarming situation, particularly in those countries which are not developed. In all food, Pakistan needs to increase productivity. For managing food security in Pakistan, it is also necessary to understand the food security dimensions, policy impact on food supply, and future challenges of agricultural growth (Ahmad and Farooq, 2010). The concept of food security continues developing over time, in literature almost 450 indicators and 200 definitions available. Food security states the access to a sufficient quantity of food for meeting dietary energy needs. When a country in domestic production achieves a balance between demand and supply it is called self-sufficient in food. Food availability does not mean assure of food accessibility. In the mid-1970, scholars defined food security as all public's access to enough food for productive and strong life (Pinstруп-Andersen, 2009).

In food security the dimensions: Food availability and food accessibility are significant dimensions. Food availability refers to the situation in a country when sufficient amounts of food are available to every individual. Food accessibility refers to the situation having both physical and economic resources, to obtain appropriate food. Availability of food at the country level does not assurance of food security due to lack of roads, low incomes, and infrastructure quantities. (Timmer, 2000). Land is an important natural resource for mankind. With the continuously

increasing world population, the demand for shelter and food is increasing. The production of food is mostly dependent on water and land resources (Arif and Khalid, 2007).

Pakistan is an agricultural country with a 19.8 percent agricultural contribution in Gross Domestic Product GDP, 42.3 percent of the total population engaged with agriculture as a source of livelihood, and 45 % export consisting of agricultural commodities. In rural areas population is declining continuously from 61.4 % in 2014 to 60.1 % in 2016 while an increase in the urban population is 38.5% to 40.0% from 2014 to 2016. Most cities are spreading over agricultural land, changes in agricultural land in urban centers might create food conflicts in the future. (Magsi et al., 2017). Total cultivated land is an important factor that influences the food security situation in Pakistan. People get more food and less chance of food insecurity if cultivated land increases. Cultivated area decreases due to the increasing population in Pakistan, and food insecurity situation arises because food is not sufficient for the growing population. (Mamoon and Kinza, 2017). The total land area of Pakistan is about 803,940 square kilometers. Approximately 48 million hectares are often classified as unusable for mountain slopes, forestry or agriculture consists, urban settlements, and deserts. Source: *U.S. Library of Congress*

The cropland availability is a very important issue due to its implications both on the likelihood of meeting future dietary needs for the whole world and on food security in many countries (FAO, 2011). In Pakistan, the process of urbanization has a huge influence on the economy and society. Farmland size affects the size of farm output. The increase in urbanization is alarming. For residential and commercial use, the demand for land increases. Food production is affected due to a reduction in agricultural land. Agricultural land changed to other land use would have a negative impact on the production of food (Appiah et al., 2019). Agricultural contains 80 percent of the export of the country consisting on agricultural and agricultural contains 24 percent of our gross domestic product GDP. According to, Khurram Dastgir the Minister of Commerce, during 2015-2016, the export of agricultural commodities declined by 13.5 percent as compared to 2014-2015. Another main effect is the continuous influx of population into cities. In Pakistan, the population migration from rural to urban has been increasing over the years. To accommodate their rising population, cities are spreading out over land currently, there is no law regulating the purchase and utilization of agricultural land, so large tracts of agricultural land have already been converted to residential and commercial properties (Shanzay Asim, 2007).

Demand for agricultural products increases due to the rapid increase in population. The country's population is growing at the rate of 2.4% per annum as reported by the 6th Population and Housing Census of Pakistan 2017. Over the past 50 years, Pakistan's cities have expanded in terms of their size and population. In Pakistan urbanization has grown from 17.5 percent in 1951 to 32.5 present in 1998 according to the 1998 census. For economic development reducing poverty, hunger and food security are pre-requisites and these are an essential part of MDG3 (Timmer, 2004).

Many studies suggested that cultivated land is positively related to food security (Garrett & Ruel; Grootaert & Narayan; Malik and Nazli, 1999; Timmer, 2004). This study investigated the effect of agricultural land, on food security in Pakistan from the period 1990 to 2016. The

study also considered the food security dimensions, food availability, and food accessibility. In previous studies, food accessibility did not consider however this study fills this literature gap.

### **1.1 Objectives of the study**

- To analyze the association between agricultural land and food security in Pakistan.
- To examine the impact of macroeconomics variables credit to agricultural sector, urbanization, food import, and GDP growth rate on food security.
- Based on the findings, to suggest recommendations to enhance food security.

### **1.2 Research questions**

In the context of the above problems statement following research question emerges:

- What is the influence of agricultural land on food security in Pakistan?
- What is the association between food security and credit to agricultural sector, urbanization, food import, and GDP growth rate?

## **2 Literature Review**

In the literature review, we analyze the factors that affect food security.

Sasson (2012) studied the causes and challenges of food insecurity in Africa. Food insecurity is not just about insufficient food availability and production but it is also about the poor quality of the food. The harmful condition of women and children is that female teenagers in the same household receive less food than their male counterparts. Insufficient food was the main cause of food insecurity. Self-sufficiency of food is the first challenge that faces all developing countries. To achieve sufficient food, countries should promote free trade because production cost is more than imported food. The study also suggested that it is needed that international donors fulfill their commitment to help rural communities and African farmers and protect them against the competition, dumping of cheap Agricultural food products from overseas and unfair trade.

Jiang et al. (2013) analyzed the urban expansion influence on agricultural land in China. Agricultural land is measured by cropping frequency. For the construction of the multi-cropping index, data had taken area of cultivated land and total sown area of crop. The data of total sown area collected from china statistical yearbook in 1995, 2000 and 2005. Multi cropping index was the dependent variable and the area of cultivated land, GDP per capita, the total length of highways, and agricultural investment per capita were selected as independent variables. Linear panel econometric model results showed that urban conversation of cultivated land and area of per capita cultivated land were adversely related with multi-cropping index. Finally, results concluded that urban expansion is negatively related.

Adom (2014) examined the causes of unsustainable food access and food availability in Ghana. Food availability had taken as the dependent variable and measured by total food supply in kilocalories per capita per day while domestic interest rate, human capital index, average maize prices, domestic inflation, real exchange rate, and Arable land had taken as independent variables. To analyze the determinants of food availability data obtained in the period 1961 to 2011 from FAO statistics, United States Department of Agriculture, IMF international financial statistics, World Bank, and Penn World Tables. Results showed that foreign and domestic interest rates,

exchange rate, domestic prices, and energy price are negatively linked with food availability while arable land, real income, liberalization of agricultural trade are positively associated with food availability. In the access model exchange rate, domestic interest rate, and oil price are negative influences. However exchange rate, arable land, crop yield, liberalization of agricultural trade foreign and domestic interest rate, and inflation had a common effect. The stability model showed that higher income increases access to food. The policy implication is that when the government addresses food access and food availability, they should jointly target variables with higher common effects.

Applanaidu and Baharudin (2014) investigated the relationship among food security and macroeconomic variables: exchange rate, population, food price index, biodiesel production, and rural development government expenditure in Malaysia. The data were obtained in the period 1980-2012 from food and agriculture organizations, statistics department of Malaysia websites, and international finance statistics. As a proxy, the food production index was to measure the shock of food security. Vector autoregressive approach was used to find out the association between food security and macroeconomics variable. The outcomes showed that population and food price index positively related to food security. It indicates that food insecurity is more due to an increase in population and food prices. The results of this study recommended that policymakers expend more on rural development. This will increase and support agriculture development specifically on food production.

Silvestri et al. (2015) analyzed the factors that contributed to household food security and the agricultural option and strategies which are benefited particular female household food security in East Africa. For this purpose, 600 different types of households were selected like male-headed, female-headed, food insecure, and food secure food. In household survey information obtained such as household assets, household size, ownership of land and livestock, agricultural input and use of labor for cropping agricultural, utilization of agricultural products, and source of livelihood. The dependent variable was food security while income, assets, agricultural yield, and labor were selected as independent variables. In this study, two types of analysis are made by the used logistic regression model. First analyzed the characteristics of male-headed, female-headed, food secure, and insecure households, and secondly analyzed the factor that affects household food security. Results of the study showed that family size was adversely associated with food security if large family size household had more food insecure and food insecurity more in a male household headed than a female household headed and family size negatively associated with food security.

Sidhu, Kaur, and Vatta (2008) examined the depth of food, determinants, and nutritional insecurity in food surplus areas in the state of Punjab. To represent the food-surplus zone in the state, 262 households from the district of Ludhiana were selected. By using the logit model results of the study revealed that food insecurity exists even in the food surplus area and the household their income low are more food insecure. In food surplus areas family size and level of income had found a more important factor that effecting nutritional and food security. Only enhancement in production does not guarantee food and nutritional security. The study suggested that employment opportunities and income are very important to minimize food insecurity and malnutrition from more Vulnerable sections of the society.

Hye and Khan (2010) analyzed the determinants of agricultural land expansion in Pakistan. The study was analyzed by using data in the period 1971 -2007. Data were taken from World Development Indicator and Pakistan economic survey. To find out the empirical result JJ co-integration technique was used. Results concluded that technology fertilizer, agricultural price, and irrigation were positively associated with agricultural land expansion. And rainfall, agricultural income, and human population were a negative impact on agricultural land expansion.

Bashir, Schilizzi, and Pandit (2012) examined the food security situation of landless rural households in the Punjab province of Pakistan. Data were obtained from 576 landless households through interviews. Food security is measured by used per capita calorie intakes. For observing the food security situation data was analyzed in two ways first for analyzing the status of household food security, second for analyzing the deterrents of food security. Results showed that in the selected sample 27% of households were food insecure. The monthly income and education of household heads were positively related to household food security, while household families' size and household head's age were adversely linked with household food security. The study suggested that creating opportunities for income-generating, focusing on education and family planning programs can improve rural household food security.

Awan and Imran (2015) analyzed the factors that influence food price inflation in Pakistan. For analysis annual data in the period of 1980-2013 was obtained from the government of Pakistan and the world development indicator. Food price was a dependent variable and GDP per capita, money supply, fertilizer, foreign aid, exchange rate, and fuel prices were independent variables. To estimation, the long-run and short-run relationship among variables, Augmented Dickey-Fuller Test ADF, Vector Error Correction Model, and Johansen Co-integration technique was employed. Their finding showed that GDP per capita, money supply, foreign aid, and fuel prices are positive while the exchange rate is adversely associated with food prices in Pakistan. The study suggests that government should invest in building new roads from village to market in cities, for minimizing the transportation cost and support the private sector to invest in pesticides and fertilizer this will help to reduce food inflation.

Ahmad and Ali (2016) tested the Malthus theory of growing population growth in the case of Pakistan. The objective of the study was to analyze how rising populations are associated with food security and agricultural productivity. Data were obtained in the period 1971 to 2011 from the economic survey of Pakistan, international financial statistics, and world development indicators. The dependent variable was Food security it measured by food availability. Population growth rate, consumer price index, GDP growth rate, consumer price index, time trend, in GDP % share of agriculture were selected as independent variables. Johansen Co-integration technique was employed to analyze the long-run relationship between the variables; the result showed that the population growth rate had a negative relationship with food availability while time trend, agricultural growth, and inflation had a positive and significant association with food availability. This study suggested that there is a need to focus on research and development in yield varieties, yields in food items less due to old varieties of seeds.

Mamoon and Kinza (2017) investigated the influence of climate change and area under cultivation on food security in Pakistan. Data were obtained from 1980 to 2014 from food and agricultural organization, world development indicator, and world climate data center. The

dependent variables were food security index and food production index while Population growth, GDP growth rate, average rainfall mm per year, the area under cultivation, road kilometers. Credit to agricultural sector, total water supply, credit to agriculture sector, food imports, biological and mechanical inputs were independent variables. To measure food security, the food production index is used as a proxy of food security. The study was analyzed to find out the impact of rainfall, irrigated land, and technology on food security. By using the Autoregressive distributed lagged technique, results showed that rainfall, technology, and climate change were positively influenced on food security while GDP, population growth, aggregated land were negatively connected with food security. The study suggested that by using advanced technology in the country agricultural production can be increased. Government should spend more expenditure on the agricultural sector to enhance the agricultural production in Pakistan.

Empirically studies on the agricultural land impact on food security and other food security determinants are analyzed. Studies investigate the determinants on food security at the household and national level such as agricultural land, population growth, household size, household income, credit to agricultural land, exchange rate, food import, and agricultural price however, not many studies consider the agricultural land expansion impact on food security in Pakistan. Studies (K. Ahmad and Ali, 2016; Awan and Imran, 2015; Bashir et al., 2012; Iram and Butt, 2004; Mamoon and Kinza, 2017) find out that agricultural land, household income, and credit to agricultural sector, positive while exchange rate and population growth negatively associated with food security. Moreover, the studies suggest the government should invest in the agricultural sector to achieve more production and create employment opportunities to extend people's access to food.

### 3 Methodology

#### 3.1 Model Specification

The present study considered agricultural land and other variables' influences on food security in Pakistan. Models are as follow:

Model 1

$$\text{LFAV} = f(\text{LAL}, \text{LCA}, \text{LUP}, \text{LFI}) \quad (1)$$

Where,

FAV= Food Availability

AL= Agricultural Land

CA= Credit to Agricultural Sector

UP= Urban Population

FI= Food Import

Model 2

$$\text{LFAC} = f(\text{AL}, \text{GDP}, \text{FI}, \text{LUP}) \quad (2)$$

Where,

FAC= food Accessibility  
 AL= Agricultural land  
 GDP= Gross domestic product growth rate  
 UP= urban population  
 FI= food import

### 3.2 Data and Method

To find the impact of agricultural land and other variables: GDP growth rate, food import, credit to agricultural sector, and urbanization impact on food security in Pakistan, data from 1990 to 2016 has been taken from Pakistan economic survey, world development indicator, and FAOSTAT. To measure food security used two dimensions of food security, food accessibility and food availability as dependent variables. Food availability is measured by kilocalories kcal per capita per day available for each individual in the total population. Food availability data has been obtained from FAOSTAT food balance sheets. Food accessibility is measured by food price indices. Data of food price indices and credit to agricultural sector (Rs in million) obtained from Pakistan economics survey. Agricultural land measured in sq. km (square kilometers). The data of agricultural land, GDP annual growth, urbanization, and food import are obtained from the world development indicator. To examine the impact of the agricultural land expansion and other selected macroeconomics variables (food import, GDP, urbanization, credit to agricultural sector) on food security in Pakistan, ARDL bound testing procedure is used.

## 4 Results and Discussion

The study analyzes the impact of agricultural land on food security in Pakistan by using the ARDL co-integration method. This section describes the empirical results of models 1 and 2.

### 4.1 Results for model 1

$$\text{Model 1. LFAV} = f(\text{LAL, LCA, LUP, LFI}) \tag{3}$$

### 4.2 Descriptive Analysis

The descriptive analyses define the degree of variation of the variable and degree of reliability.

**Table 1**  
*Model 1- Descriptive Statistics*

	FAV	AL	CA	UP	Food Import
Mean	2385.741	361015.6	145456.7	50234506	13.314
Median	2398.000	360630.0	73446.00	49598802	12.149
Maximum	2484.000	369720.0	391353.0	70005347	20.728
Minimum	2224.000	352060.0	14479.00	32923813	8.882
Std. Dev.	63.303	690.495	134758.7	11162903	2.954
Skewness	-0.751	-0.108	0.585	0.1495	0.920
Kurtosis	3.211	1.893	1.783	1.8659	3.072
Jarque-Bera	2.59	1.432	3.204	1.547	3.818

Probability	0.273	0.488	0.201	0.461	0.148
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(Total No of observation=27)

### 4.3 Unit Root Results

To check the stationary of the data different tests are used, such as GLS Augmented Dickey-Fuller ADF, Ng-Perron, Dickey-Fuller, ERS, and Phillips-perron test. This study used Augmented Dickey-Fuller (ADF) test to check the stationary of the variables. Results revealed that all variables are stationary at first difference and level. Table 2 shows the results of the ADF logged series. According to the ADF unit root test, all the time series variables Food Availability, agricultural land, credit to agricultural land, urban population, and food import is a mixture of both I(0) and I(1) and none of the variables is stationary at I(2). Therefore in the study used the ARDL approach of co-integration.

**Table 2**  
*Result of Augmented Dickey-Fuller Test Stationary by using ADF*

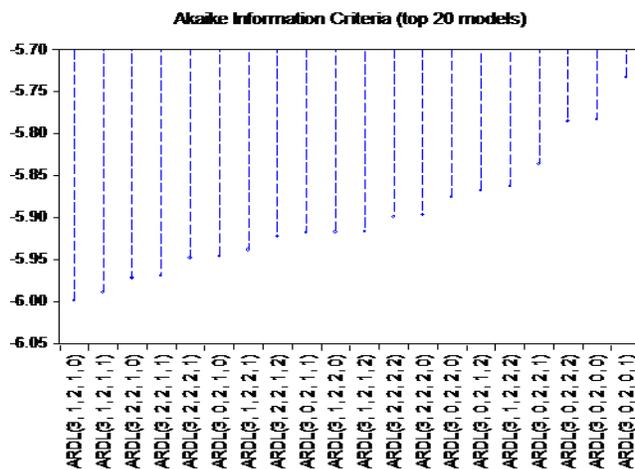
With intercept		with intercept and trend		
Variable Name	T-value	P-value	T-value	p-value
LFAV	-6.650	0.000**	-3.453	0.067
LAL	-4.171	0.004*	-3.815	0.037
LCR	-5.031	0.000**	-5.003	0.003
LUP	-5.031	0.000**	-3.495	0.063
LFood Import	-2.320	0.000**	-6.915	0.00

Notes: \*sign shows variables are stationary at level and \*\* indicate variables stationary at 1<sup>st</sup> difference. Here agricultural land stationary at 1(0) while all other variables are 1(1).

### 4.4 Optimal ARDL Models Selection

The best model is ARDL (3, 1, 2, 1, 0), according to Akaike Information Criterion, where the value of AIC is minimum.

**Figure 1**  
*Optimal ARDL Models Selection*



#### 4.5 Test of Co-integration: Bound Test

To test the level of association between independent and dependent variables, the bound test approach used in the study, developed by Pesaran et al. The significance levels of the variables are tested on the basis of standard F- and t-Statistic. In table 3 results of the bound test shows that F Statistics (3.899) value is greater than the lower and upper bound of the critical value at a 10 % significance level. The null hypothesis rejects, which means there is a long-run relationship exists among variables.

**Table 3**  
**Bound Test Results**

ARDL Bound Test Results		
Estimated Models		
Optimal lags (3, 1, 2, 1, 0)	(0) Bound	(1) Bound
Fstatistic	3.8995*	
Significance (%)		
10	2.45	3.52
5	2.86	4.01
2.5	3.25	4.49
1	3.74	5.06

Null hypothesis: There is no long-run relationship exist The F-statistic >upper critical value I(1)3.52 at 10% level

#### 4.6 The Estimation of Long Run and Short-Run Relationship

After confirming the co-integration relationship exists, the equation of the selected ARDL (3,1,2,1,0) model based on AIC (Akaike information criteria) is estimated for the long-run coefficients. The estimated results of the ARDL long run show that agricultural land is positively related to food availability. It has a significant impact on food availability. One percent increase in agricultural land will lead to a 0.694% increase in food availability. People get more food or less chance of food insecurity due to the increase in cultivated land in Pakistan. Study findings are consistent with the results of Apanovish and Mazur (2018), Abeam et al (2018), Ahmed and Ali (2016).

The coefficient of credit to agricultural sector is positively significant associated with food security. It means that a one percent increase in credit to agricultural sector will lead to a 0.064 % increase in food availability in Pakistan. Credit to the agricultural sector plays a very important role in the agricultural sector to enhance production. Study consistently the results of Abeam et al (2018), Mostly farmers faced the problem of credit shortage for implementation of modern techniques in the agricultural sector. (Malik and Nazli, 1999).

Urbanization comes up with a negative significant impact on food availability. it means a one percent increase in urban population 0.196 percent decrease in food availability in Pakistan. Study results match the results of (Jiang et al., 2013; Szabo, 2016) urbanization negatively related to food security. Urbanization carries out immediate two impacts on agriculture: the significant reduction of agricultural population and land. Indirectly it raises the level of agricultural modernization. The most essential urbanization means is the decline in agricultural population, because the people who shift from rural to urban, their identity is a change from producer to

consumer of food. In the field of growing food, there is a fewer number farmers. According to (Szabo, 2016) urbanization is negatively related to food security.

The coefficient of Food import is positively significantly associated with food availability. One% increase in food import will increase food availability by 0.056% percent. This study result also matches the finding by Mamoon and kinza (2017).

In the short run Food import and Credit to agricultural sector, positively significantly related to food availability.

In short-run estimation, a negative value of error correction model ECM shows that food availability comes back from disequilibrium to long-run equilibrium at the speed of .148% from the period of shock.

**Table 4**  
*The Estimation of Long Run and Short-Run Relationship (3, 1,2,1,0)*

Long-run estimation			Short-run estimation		
Dependent variable: LFAV	Coefficient	Prob.	Dependent variable: LFAV	Coefficient	Prob.
LAL	0.694	0.014	D(LFAV(-1))	0.746	0.014
LCA	0.064	0.005	D(LFAV(-2))	0.489	0.175
LUP	-0.196	0.069	D(LAL)	0.606	0.184
LFood Import	0.056	0.002	D(LCR())	0.000	0.995
C	1.366	0.5467	D(LCR(-1))	-0.085	0.011
			D(LUP)	6.515	0.044
			D(LFood Import)	0.085	0.022
			CointEq(-1)	-1.485	0.001

(Total No of observation=24)

#### 4.7 Diagnostics Test

To check the robustness serial correlation LM test, heteroscedasticity ARCH, and normality test are applied. The diagnostics test showed that the problem of autocorrelation does not exist on the basis of probability value which is greater than five percent accept the null hypothesis. The null hypothesis is there is no autocorrelation exist. The probability value of the heteroscedasticity test is great than five percent therefore null hypothesis, there is no heteroscedasticity cannot be rejected. In normality test on the basis of p-value which is greater than five percent accept null hypothesis which is error term is normally distributed.

**Table 5**  
*Diagnostics Test Results*

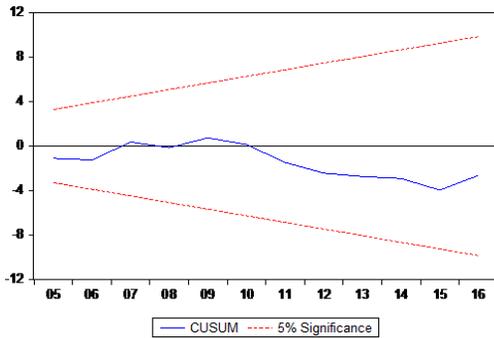
Breusch-Godfrey Serial Correlation LM Test: Null: There is no autocorrelation			
F-statistic	0.997	Prob. F(2,10)	0.402
Obs*R-squared	3.992	Prob. Chi-Square(2)	0.135
Heteroskedasticity Test: ARCH Null: There is no heteroscedasticity			
F-statistic	0.009	Prob. F(1,21)	0.922

Obs*R-squared	0.010	Prob. Chi-Square(2)	0.918
Normality Test	Null: The residuals are normally distributed		
Jarque –Bera ( 0.606)	Probability(.738)		

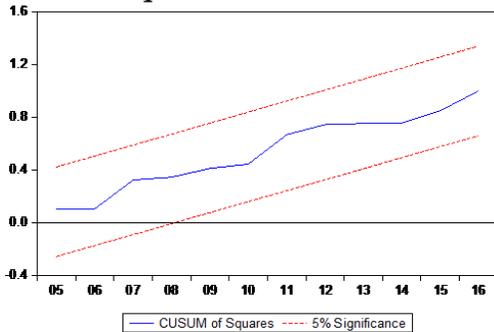
#### 4.8 CUSM and CUSUM Square

The stability of long-run coefficients has been examined with the help of the cumulative sum of recursive residuals (CUMS) of the CUSUM SQUARE test. Figures 2 and 3 show the stability at 5 percent level because the estimated line lies between the lower and upper critical line.

**Figure 2**  
*CUSUM Test*



**Figure 3**  
*SUSUM Square Test*



#### Results for model 2

Model 1 LFAC. = f (AL, GDP, Food Import, LUP)

(4)

#### 4.9 Descriptive Analysis

In the following table 5 summary of data, series includes median mean maximum std. dev skewness kurtosis probability and Jarque –Bera.

**Table 6**  
**Model 2- Descriptive Statistics**

Variables	FAC	AL	GDP Growth	Food Import	UP
Mean	137.506	361015.6	4.143	13.314	50234506
Median	111.740	360630.0	4.396	12.149	49598802
Maximum	286.150	369720.0	7.705	20.728	70005347
Minimum	46.330	352060.0	1.014	8.882	32923813
Std. Dev.	69.630	5690.495	1.816	2.954	11162903
Skewness	0.436	-0.108	0.269	0.920	0.149
Kurtosis	1.960	1.894	2.525	3.072	1.865
Jarque-Bera	2.067	1.433	0.580	3.818	1.547
Probability	0.355	0.488	0.747	0.148	0.462

(Total No of observation=27)

#### 4.10 Augmented Dicky Fuller Unit root test

In following table 6, show the results of ADF, agricultural Land AL and GDP growth is stationary at Level while FAC (food accessibility), and Food Import are stationary at 1<sup>st</sup> difference. According to ADF, all the time series variables FAC, AL, urban population, and Food Import are a mixture of both I(0) and I(1) and none of the variables is stationary at I(2). Therefore ARDL approach of co-integration is used in the study.

**Table 7**  
**Result of Augmented Dickey-Fuller Test Stationary by using ADF**

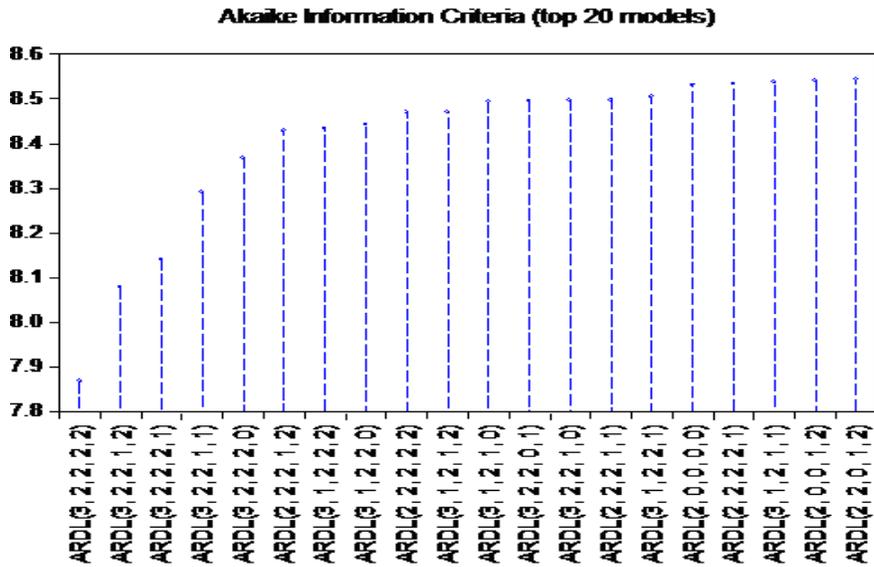
Variable Name	With intercept		with intercept and trend	
Variable Name	T-value	P-value	T-value	p-value
FAC	-5.577	0.000**	-4.899	0.005
AL	-4.250	0.004*	-3.886	0.033
GDP	-3.727	0.012*	-3.575	0.055
LUP	-10.606	0.000*	-7.630	0.000
LFood Import	-7.114	0.000**	-6.915	0.000

Notes: \*sign show variables are stationary at the level and \*\* indicate variables stationary at 1<sup>st</sup> difference. Here agricultural land GDP growth rate and Urbanization are stationary at 1(0) while other variables are 1(1).

#### 4.11 Optimal ARDL Models selection

According to Akaike Information Criterion, the best model is ARDL (3, 2, 2, 2, 2) where the value of AIC is minimum.

Figure 4



4.12 Test of Co-integration: Bound Test

To test the level of association between independent and dependent variables, the bound test approach used in the study, developed by Pesaran et al. The significance levels of the variables are tested based on standard F- and t-Statistic. The null hypothesis is there is no co-integration relationship among variables. In table 7 results of the bound test shows that F Statistics (10.796) value is greater than the lower and upper bound of critical value at a 1 % significance level. The null hypothesis rejects it means that there is a long-run relationship exists among variables.

Table 8  
Bound Test Results

ARDL Bound Test Results		
Estimated Models		
Optimal lags (3,2 2,2, 2)	(0)Bound	(1) Bound
Fstatistic10.796		
Significance(%)		
10	2.45	3.52
5	2.86	4.01
2.5	3.25	4.49
1	3.74	5.09

#### 4.13 The Estimation of Long Run and Short-Run Relationship

After confirming the co-integration relationship exists, the equation of the selected ARDL (3,2,2,2,2) model, based on AIC (Akaike information criteria) estimated for the long-run relationship.

The estimated results of the ARDL long run show that agricultural land is negatively related to food accessibility. It has a significant impact on food accessibility. One square kilometer Increase in agricultural land will lead to decreases in food price 0.003 in long-run. It means that due to expanding agricultural land, food accessibility will be increased. According to Appiah et al (2019) People get more food or less chance of food insecurity due to an increase in cultivated land. Agricultural land is negatively correlated with food prices. Food production declines due to loss in agricultural land, reduction in food production has to lead to an increase in food prices. (Appiah et al., 2019).

The coefficient of GDP growth is also negative significantly associated with food price. It means an increase in GDP growth will reduce the food price and increase the accessibility on food. One percent increase in annual GDP growth will reduce food price indices by 6.127. The study result is consistent with the negative finding Ahsan et al (2011). The negative relationship between food price and per capita income may indicate Engle aggregation that is with an increase in income the percentage of expenditure on food items decline (Ahsan et al., 2011).

The coefficient of urbanization comes up with positive and significantly related to food price. One % Increase in urban population will lead to an increase in food price indices by 288.199 and food accessibility will be reduced. Study consistent the findings of (Szabo, 2016) urbanization negatively related to food security.

Urbanization declines the agricultural population because the people who shift from rural to urban identity are changed from producer to consumer of food. In the field of growing food, there is a fewer number farmers. Due to urbanization demand for food increase while production of food decrease, which lead to a rise in food price.

Food import is positively related to food accessibility and is a significant impact on it in long run. On percent increase in food, import will lead to an increase in food price indices by 42.56 This result match the findings of (Abdullah and Kalim, 2009) that is food import positively associated with food price it's mean that increase in food import accessibility on food will decrease. Taxation on imported food items increases the price of food. Food inflation increases due to increase food imports because of higher the price of food items at the global level (Abdullah and Kalim, 2009).

In the short-run estimation negative value of the error correction model, ECM shows that food accessibility comes back from disequilibrium to long-run equilibrium at the speed of .189% from the period of shock.

**Table 9**  
**The Estimation of Long Run and Short-Run Relationship(3,2,2,2,2)**

Long-run estimation			Short-run estimation		
Dependent variable: FAC	Coefficient	Prob.	Dependent variable: FAC	Coefficient	Prob.
AL	-0.003	0.000	D(FAC(-1))	1.435	0.002
GDP	-6.127	0.000	D(FAC(-2))	0.468	0.024
LFood Import	52.463	0.003	D(AL)	-0.003	0.006
LUP	288.941	0.000	D(AL(-1))	0.005	0.027
C	3633.806	0.000	D(GD)	-9.013	0.003
			D(GDP(-1))	6.242	0.016
			D(LFood Import)	33.494	0.348
			D(LFood Import (-1))	-42.558	0.137
			D(LUP)	9360.850	0.412
			D(LUP(-1))	- 19125.7	0.102
			CointEq(-1)	-1.893	0.003

(Total No of observation=24)

#### 4.14 Diagnostics Test

To check the robustness serial correlation LM test, heteroscedasticity ARCH, and normality test are applied. The diagnostics test showed that problems of autocorrelation, heteroscedasticity do not exist based on probability value which is greater than five percent accept the null hypothesis. In normality test on the basis of p-value which is greater than five percent accept Null hypothesis which is error term is normally distributed.

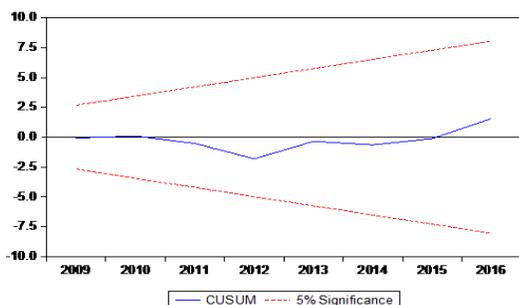
**Table 10**  
**Diagnostics Test**

Breusch Godfrey Serial Correlation LM Test: Null: There is no autocorrelation			
F-statistic	2.008	Prob. F(1,7)	0.199
Obs*R-squared	5.350	Prob. Chi-Square(1)	0.020
Heteroscedasticity Test: ARCH Null: There is no heteroscedasticity			
F-statistic	0.484	Prob. F(1,21)	0.494
Obs*R-squared	0.517	Prob. Chi-Square(2)	0.472
Normality Test Null: The residuals are normally distributed			
Jarque –Bera (0.980)		Probability (0.613)	

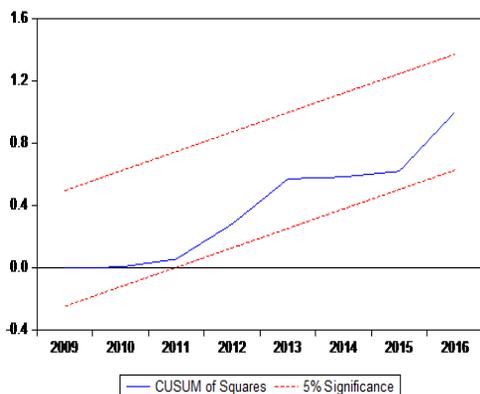
#### 4.15 CUSUM and CUSUM Square

The stability of the long-run coefficient has been examined with the help of the cumulative sum of recursive residuals (CUSM) of the CUSUM SQUARE test. Figures 5 and 6 show that stability exist at a five percent level because the estimated line lies between the lower and upper critical lines.

**Figure 5**  
*CUSUM Test*



**Figure 6**  
*CUSUM Square Test*



## 5 Conclusion and policy recommendation

The study empirically examined the impact of the agricultural land expansion and other selected macroeconomics variables (food import, GDP, urbanization, credit to agricultural sector on food security in Pakistan by using the ARDL bounds testing procedure proposed person shin & smith (2001). The main objectives of the study are to find out the influence of agricultural land expansion on food security in Pakistan and on the basis of findings, suggest recommendations to enhance food security. According to our knowledge not many studies on the agricultural land expansion impact on food security in Pakistan. For this purpose, data had taken from the period 1990 to 2016. Food security is measured by using the two food security dimensions, food accessibility, and food availability. Food availability is measured by food supply (kcal/capita/day) and food accessibility is measured by food price indices. Data on food availability was obtained from FAOSTAT food balance sheets. Data of food price indices and credit to the agricultural sector (Rs in million) obtained from Pakistan economic survey. The data of agricultural land, GDP per capita growth, urbanization, and food import are obtained from the world development indicator.

Study findings showed that agricultural land has a significant positive impact on food security. Credit to agricultural sector, GDP and food import also positive & significantly related

with food security while urban population negatively related with food security. Moreover if agricultural land increases then food availability and accessibility will increase. GDP growth rate is positively related to food accessibility. Food import is positively significantly associated with food availability and negatively related to food accessibility. Urbanization is also negatively related to food accessibility and food availability.

On the basis of findings, the study suggests the following policy recommendations:

- The study suggested that agricultural land expansion is a good strategy for food security.
- Government should increase the credit to agricultural sector and provide credit to the farmer at the minimum interest rate.
- The government needs to spend more on rural development.
- Government should create employment opportunities to enhance people's access to food.
- Government should make a rule to restrict agricultural land to urbanization.
- The study suggests that government should introduce new technology to achieve more production.

This study is important for policymakers and suggests to the researcher to carry out such kind of study by using the other factors that affect food security and concenter the dimensions of food security, food accessibility, food accessibility, food utilization, and food stability. However, many other factors affect food security.

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