https://doi.org/10.17221/252/2020-AGRICECON

# Revisiting the effects of relevant factors on Pakistan's agricultural products export

*Zaid Ashiq Khan, Mansoor Ahmed Koondhar, Noshaba Aziz, Uzair Ali, Liu Tianjun**

*College of Economics and Management, Northwest A&F University, Yangling, Shaanxi, China*

**Corresponding author: ltj168168@nwsuaf.edu.cn*

**Citation:** Khan Z.A., Koondhar M.A., Aziz N., Ali U., Tianjun L. (2020): Revisiting the effects of relevant factors on Pakistan's agricultural products export. Agric. Econ. – Czech, 66: 527–541.

**Abstract:** Pakistan is an agriculture-based country, so the agricultural sector is known as the backbone of the national economy. Considering the national economy and the agricultural industry, it is necessary to focus on earnings through agricultural products export to improve the livelihood of local farmers. Therefore, the current study aimed to analyse the short-term and long-term factors affecting agricultural products export. The annual time series of 1976–2016 were collected from World Bank indicators, the Food and Agriculture Organization, and the Statistical Bureau of Pakistan. An autoregressive distributed lag, along with a vector error correction model, was employed. A cointegration test showed long-term associations between the selected variables. While the autoregressive distributed lag model confirmed the short-term correlation between area sown and crop production towards agricultural products export, there is no long-term relationship between the selected variables. In addition, the bidirectional correlation between employment in agriculture and agricultural products export was confirmed by the vector error correction model. Therefore, it is essential to increase agricultural production with the available natural resources to increase foreign earnings.

**Keywords:** agricultural employment; agricultural products export; area sown; influencing factors; population

The agricultural sector plays a dominant role in Pakistan's economy and contributes to 18.9% of the country's gross domestic product (GDP). In Pakistan, nearly 60% of the population live in rural areas and directly or indirectly depend on agriculture for their livelihoods. This sector absorbs 42.3% of the country's total labour force. Furthermore, it serves as an important foundation of foreign exchange earnings and helps other sectors in growth stimulation (GOP 2018).

A country's economy can be developed by improving its international trade (Frankel and Romer 1999). International trade quantitatively improves the economy, serves as an engine for economic growth, and is a key source of foreign exchange (Makhmutova and Mustafin 2017). According to a study, an increase in the agricultural exports of Pakistan results in a decrease in the exchange rate, which reinforces the country's economic development (Atif et al. 2017).

The total cropped area of Pakistan is 23.3 million ha, out of a total area of 79.6 million ha. Globally, Pakistan ranks 10$^{th}$ in rice production and is among the top 10 producers of cotton, wheat, mango, sugarcane, oranges, and dates. The major Pakistani crops are wheat, rice, and sugarcane, which contribute by 2.1% to the country's total GDP. The total agricultural production of the country is worth USD 66.43 billion. Despite

Supported by the National Natural Science Foundation of China General Project (Grant No. 71773089) and by the Peasant Household Safety Production Behavior by Humanistic and Social Science Project, Ministry of Education of the People's Republic of China (Grant No. 16XJA790006).

https://doi.org/10.17221/252/2020-AGRICECON

its impressive and continuously growing agricultural production, the country is still facing high levels of food insecurity. According to a global report published jointly by the Food and Agriculture Organization (FAO), the World Food Program (WFP), the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the International Fund For Agricultural Development (IFAD) in 2019, 20.3% of Pakistan's population (40 million people) are undernourished/food-insecure. The total agricultural exports in the year 2019 were worth USD 6 092 billion, while agricultural imports were worth USD 4 201 billion (Dowlatchahi 2020).

The most important and provocative issue for Pakistan is using the available natural resources to produce enough food to meet the food demand for the fast-growing population. Thus, Pakistan is struggling to tackle this critical issue, as urbanization and overpopulation is resulting in reduced resources and arable land. Along with the growth in agricultural products export (*APE*), new challenges have emerged for rural society and agriculture, including rapid population growth, food security, new agricultural technology, credit availability, water scarcity, increasing prices of agricultural inputs, electricity shortage, and pollution. According to the 2017 population census, Pakistan's population is growing at 2.4% per annum (GOP 2019). This rapid growth of the population is of great concern due to the burgeoning demand for agricultural products. With the upsurge in agricultural product demands and decreasing natural resource availability, it is now essential to improve employment in agriculture and agricultural productivity, and better support agricultural sector development (Rehman et al. 2019b).

It is imperative to comprehend the subtleties of causality between Pakistan's agricultural product exports and factors that impede growth. Many researchers have observed agricultural production and influencing factors. However, no research is consistent. The purpose of our study is to explore the nexus of agriculture productivity along with the factors (social and economic factors) influencing the agricultural product exports of Pakistan from 1976 to 2016. We expect the study findings to not only enrich the existing literature but also expand our understanding of certain causal relationships, so as to help guide policymaking with respect to the growing population and food security, open more gates to foreign direct investments, and increase sowing areas and credit availability for farmers.

## LITERATURE REVIEW

Based on previous research, a rapid increase in the population generally slows down the country's agriculture production and export (Hoffmann 2013). In developing countries, the population growth rate is almost double that of developed countries, which brings about difficulties in the agricultural production of these countries due to the damage to the physical environment caused by population growth, and restricts agricultural production options for farmers (Aurino 2017).

Pakistan cultivates cereal crops, including wheat, rice, maize, sorghum, millets, and barley. Among them, wheat, rice, and maize are the most consumed grains in Pakistan. Rice is the major agricultural export, and the import of wheat is increasing. This situation not only causes food security, but also cause imbalances in international trade (Salam 2012). Another study using Augmented Dickey-Fuller, Johansen's co-integration, and ordinary least square tests using time series data of Pakistan from 1950 to 2015 found a significant and long-term relationship between cereal production and agricultural GDP (Rehman et al. 2015b; Koondhar et al. 2018b). Furthermore, foreign direct investment (FDI) might be the best approach to improving agricultural exports in Pakistan. FDI plays a vital role in the formation of capital by filling the gap between investment and savings. It also improves the employment rate of the country and helps to reduce poverty (Msuya 2007). Another study found, using time series data from 1991 to 2013 with an autoregressive distribution lag (ARDL) model and a Johansen cointegration test, that agricultural FDI has a positive and significant long-term effect on the economic growth of Pakistan. Moreover, the study revealed that bidirectional Granger causality exists between economic growth and agricultural FDI in both the short and long term (Chandio et al. 2019).

Along with these factors, credit also plays an important role in overcoming the basic need for growth of the agricultural sector. Additionally, in rural economies, credit plays a key role in modernization and commercialization of agriculture (Rehman et al. 2015a). Agricultural development needs to adopt the latest agricultural technology in order to enhance production for agricultural, economic, and national development, and this is only possible in these economies when a farmer is provided with a credit facility using which the latest technological inputs can be purchased (Schultz 1980; Zuberi 1989). Institutional credit and

https://doi.org/10.17221/252/2020-AGRICECON

formal credit in Pakistan have been recognized as having a positive influence on agricultural production (Iqbal et al. 2003; Akram et al. 2008; Ahmad 2011), but a lower availability of potentially cultivable land is another constraint for its growth (Bhatti et al. 2009). This constraint is also a reflection of the growing population. The increase in household size results in land fragmentation and has a great impact on agricultural production (Bhutto and Bazmi 2007). This is because the land is owned individually or communally, and fragmentation is increasing because farmers divide their land into small pieces and share it among their children, even if the land is widely spread. The shared land may or may not be used for agriculture by their children, which results in a reduction of agricultural land and negatively affects agricultural production (Okezie et al. 2012).

Agricultural machinery has an affirmative and significant effect on agricultural production in Pakistan (Raza and Siddiqui 2014). A study on the performance of agriculture in Pakistan found that agricultural growth has fluctuated over the past six decades and that Pakistan has the lowest productivity rate due to the lack of modern technology (Zaheer et al. 2013). One important reason is that most farmers practice conventional farming due to small farm sizes and cannot afford modern technology due to lower yields (Ahmad et al. 2013). The government is trying to support these marginalized farmers to promote growth in agriculture production through small-scale innovative technologies (GOP 2016).

The ARDL model is often used for dynamic time series data to check long-term and short-term correlations between variables within a single equation framework. Many researchers have used the ARDL model for different countries, different variables, and different time spans. Shrestha and Bhatta (2018) investigated the suitable model selection for time series data analysis, and the main findings reveal that, for short-term and long-term analysis, the ARDL bound testing model is suitable. One researcher analysed the export performance of horticulture subsectors in Ethiopia using the ARDL model for the time span of 1985–2016 and concluded that the GDP of Ethiopia, the real exchange rate, and the foreign direct investment significantly influence export horticulture in both the short- and long-term (Dube et al. 2018). Bakari and Sofien (2019) investigated the agricultural trade impacts on the economic growth of China using time series data from 1984–2017 using the ARDL model. The main finding of this study was that agricultural export and domestic investment had a positive and significant long-term influence on the economic growth of China, and the short-term correlation between agricultural import, export, domestic investment, and economic growth was confirmed. Other research from Nigeria also employed the ARDL model and concluded that there is no positive and significant short-term and long-term correlation between exchange rate and agricultural products export (Akinbode and Ojo 2017). For India, Ohlan (2013) also used the ARDL model and time series data from 1970 to 2010 and concluded that there is a long-term equilibrium correlation between agricultural export and agricultural economic growth.

Many researchers have selected agricultural export, agricultural import, and cereal crop export as dependent variables and foreign direct investment, exchange rate, and domestic investment, etc. as independent variables when using the ARDL model and time series data from different countries, including Pakistan (Ahmad et al. 2017), Ghana (Baek and Koo 2009; Siaw et al. 2018), India (Ohlan 2013), Zimbabwe (Muchapondwa 2008), and Ethiopia (Dube et al. 2018). They have contributed a great proportion of literature with regard to middle- and lower-income countries, but there is still a missing link for Pakistan. The main difference between this study and previous studies is that this study selects agricultural products export as a dependent variable, while independent variables were total population, employment in agriculture, cereal production, foreign direct investment, credit to agriculture, area under cultivation, and agricultural machinery. For the period of 1976–2016, the ARDL model employed to investigate the long-term and short-term factors on agricultural products export. No researcher has covered this topic for the same study area and for the same time span. This study will contribute to the literature and help other researchers to understand the short-term and long-term factors influencing agricultural products export, and this study will help the government of Pakistan to improve agricultural products export and the agricultural GDP of Pakistan.

**Theoretical framework.** Research has been done on the nexus of agricultural products export and socio-economic factors. Such studies were conducted with different variables in various countries. The main focal point of this study is to determine a correlation between *APE* and social and economic factors and, after reaching a conclusion, provide policy implications. The conceptual framework is presented in Figure 1.

https://doi.org/10.17221/252/2020-AGRICECON

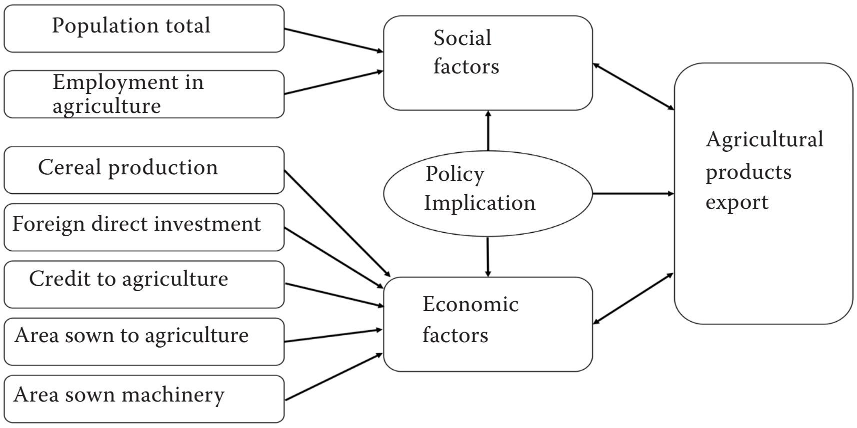


Figure 1. Conceptual framework of the study

Source: Authors' elaboration

## METHODOLOGY

**Model specification.** For this study, agricultural products export (*APE*) is selected as a dependent variable, while the independent variables are two fold: social factors and economic factors. Social factors include total population (*PoP*) and employment in agriculture (*EPA*). Economic factors include cereal production (*CP*), foreign direct investment (*FDI*), credit to agriculture (*CA*), area sown in agriculture (*AS*), and agriculture machinery (*AM*). EViews software (version 9.0) was used for data analysis using the following framework (Equation 1):

$$APE_t = f\left(PoP_t, EPA_t, CP_t, FDI_t, CA_t, AS_t, AM_t\right) \quad (1)$$

where: *APE* – agricultural products export; *PoP* – the total population; *EPA* – employment in agriculture; *CP* – crop production; *AS* – the area sown in agriculture; *AM* – the agricultural machinery; *t* – the time period.

Assuming that there is a non-linear relationship among the variables, the model can be expressed as follows (Equation 2):

$$APE_t = \varepsilon_0 + \varepsilon_1 PoP_t + \varepsilon_2 EPA_t + \varepsilon_3 CP_t + \varepsilon_4 FDI_t + \\ + \varepsilon_5 CA_t + \varepsilon_6 AS_t + \varepsilon_7 AM_t + \nu_t \quad (2)$$

where: *APE* – agricultural products export; *PoP* – total population; *EPA* – employment in agriculture; *CP* – crop production; *CA* – credit to agriculture; *FDI* – foreign direct investment; *AS* – area sown in agriculture; *AM* – the agricultural machinery; *t* – the time period; ν – error term; ε – long-run.

This study employs different estimation tests to understand the correlation between variables. Hence, we took the log of both sides of the model to make it more linearized. The model can be expressed as follows (Equation 3):

$$\text{Ln}APE_t = \alpha_0 + \beta_1 \text{Ln}PoP_t + \beta_2 \text{Ln}EPA_t + \\ + \beta_3 \text{Ln}CP_t + \beta_4 \text{Ln}FDI_t + \\ + \beta_5 \text{Ln}CA_t + \beta_6 \text{Ln}AS_t + \\ + \beta_7 \text{Ln}AM_t + P_l \quad (3)$$

where: $P_l$ – error term; *APE* – agricultural products export; *PoP* – total population of the country; *EPA* – employment in agriculture; *CP* – cereal production; *FDI* – foreign direct investment; *CA* – credit to agriculture; *AS* – area sown; *AM* – the agricultural machinery.

**Unit root tests.** To scrutinize the stationary properties of the time series study variables, the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) unit root tests were utilized. The Equation (4) for the ADF unit root test can be expressed as follows:

$$\Delta Z_t = \phi_0 + \phi_1 Z_{t-1} + \sum_{j=k}^{p} d_j \Delta Z_{t-j} + P_l \quad (4)$$

where: Δ – first difference operator; $Z_t$ – the time series; $\phi_0$ – constant; *p* – the dependent variable's optimum number of lags; $P_l$ – pure white noise error term.

The cumulative distribution of ADF statistics was provided by the ADF unit root test. The PP unit root Equation (5) is as follows:

$$\Delta Z_t = \phi + p \times Z_{t-1} + P_l \quad (5)$$

https://doi.org/10.17221/252/2020-AGRICECON

where: $Z_t$ – time series; ϕ – noise for hypothesis; $p$ – dependent variable's optimum number of lags; $P_l$ – pure white noise error term.

The PP and ADF unit root tests are based upon $t$-statistics.

**Autoregressive distributed lag (ARDL) bound testing method.** An autoregressive distributed lag (ARDL) is a famous cointegration technique with some beneficial qualities. Previous techniques have limitations: all the regressors must be integrated in the same order. The ARDL approach can be used whether the regressors are pure *I* (0), *I* (1), or mutually cointegrated (Pesaran and Shin 1998). An ARDL is a more statistically significant approach for estimating small samples (Haug 2002). With the ARDL technique, if the explanatory variables are endogenous, it can estimate the effects (Pesaran and Shin 1998; Pesaran et al. 2001). One ARDL cointegration approach (Peseran and Peseran 1997; Pesaran and Shin 1998; Pesaran et al. 2000; Pesaran et al. 2001) functioned under the commands of an unrestricted vector error correction model employed to inspect the relationships between socioeconomic factors *PoP, EPA, CP, FDI, CA, AS, AM*, and *APE* over the long term. An ARDL approach was developed as follows (Equation 6):

$$\begin{aligned}\Delta \mathrm{Ln}APE_t = {} & \psi_0 + \psi_1 \sum_{i-1}^{k} \Delta \mathrm{Ln}APE_{t-1} + \psi_2 \sum_{i-1}^{k} \Delta \mathrm{Ln}PoP_{t-1} + \\ & + \psi_3 \sum_{i-1}^{k} \Delta \mathrm{Ln}EPA_{t-1} + \psi_4 \sum_{i-1}^{k} \Delta \mathrm{Ln}CP_{t-1} + \\ & + \psi_5 \sum_{i-1}^{k} \Delta \mathrm{Ln}FDI_{t-1} + \psi_6 \sum_{i-1}^{k} \Delta \mathrm{Ln}CA_{t-1} + \\ & + \psi_7 \sum_{i-1}^{k} \Delta \mathrm{Ln}AS_{t-1} + \psi_8 \sum_{i-1}^{k} \Delta \mathrm{Ln}AM_{t-1} + \\ & + \gamma_1 \mathrm{Ln}APE_{t-1} + \gamma_2 \mathrm{Ln}Pop_{t-1} + \gamma_3 \mathrm{Ln}EPA_{t-1} + \\ & + \gamma_4 \mathrm{Ln}CP_{t-1} + \gamma_5 \mathrm{Ln}FDI_{t-1} + \gamma_6 \mathrm{Ln}CA_{t-1} + \\ & + \gamma_7 \mathrm{Ln}AS_{t-1} + \gamma_8 \mathrm{Ln}AM_{t-1} + \varepsilon_t\end{aligned} \tag{6}$$

where: *APE* – agricultural products export; *PoP* – total population; *EPA* – employment in agriculture; *CP* – crop production; *CA* – credit to agriculture; *FDI* – foreign direct investment; *AS* – area sown in agriculture; *AM* – the agricultural machinery; *i* – lag; *k* – regressors; *t* – time period; ψ –short-run; γ – long-run; $\varepsilon_t$ – the white noise error term; 0 – a constant; Σ– error correction dynamics.

The second part represents the long-term association in Equation (6). The Akaike information criterion (AIC), Schwarz criterion (SC), and Hannan-Quinn criterion (HQC) were used for the identification of the optimum lag of each series and model. The results for the AIC, SC, and HQC are shown in Figure 2. Such techniques have been used by many researchers with different objectives and variables (Hatemi and Hacker 2009; Koondhar et al. 2018a; Koondhar et al. 2020). Using the technique of ARDL bound testing for the cointegration approach, firstly, by application of fitting ARDL models, we estimated the value of the *F*-test. Secondly, the long-term association in the series was examined by applying the Wald (*F*-statistics) test. If the *F*-test's calculated value exceeded the value of the upper critical bound (UCB), the null hypothesis of no cointegration was rejected. If the *F*-test's computed value falls between the upper and lower critical bound values, the results were deemed unsatisfactory. If the *F*-test's calculated value was below the lower critical bound, then we accepted the null hypothesis of no cointegration among the variables. Furthermore, if a long-term relationship between socioeconomic factors and *APE* was found, then the long-term coefficient was estimated. The long-term model estimation Equation (7) is given as follows:

$$\begin{aligned}\Delta \mathrm{Ln}APE_t = {} & \lambda_0 + \lambda_1 \sum_{i=1}^{k} \Delta \mathrm{Ln}APE_{t-1} + \lambda_2 \sum_{i=1}^{k} \Delta \mathrm{Ln}PoP_{t-1} + \\ & + \lambda_3 \sum_{i=1}^{k} \Delta \mathrm{Ln}EPA_{t-1} + \lambda_4 \sum_{i=1}^{k} \Delta \mathrm{Ln}CP_{t-1} + \\ & + \lambda_5 \sum_{i=1}^{k} \Delta \mathrm{Ln}FDI_{t-1} + \lambda_6 \sum_{i=1}^{k} \Delta \mathrm{Ln}CA_{t-1} + \\ & + \lambda_7 \sum_{i=1}^{k} \Delta \mathrm{Ln}AS_{t-1} + \lambda_8 \sum_{i=1}^{k} \Delta \mathrm{Ln}AM_{t-1} + \varepsilon_t\end{aligned} \tag{7}$$

where: *APE* – agricultural products export; *PoP* – total population; *EPA* – employment in agriculture; *CP* – crop production; *FDI* – foreign direct investment; *CA* – credit to agriculture; *AS* – area sown in agriculture; *AM* – the agricultural machinery; *i* – lag; *k* – regressors; λ – long-run relationship; $\varepsilon_t$ – the white noise error term.

Moreover, if proof of the long-term association amongst socioeconomic factors and *APE* was found, then the short-term dynamics was estimated. The estimated model for the short term can be projected as follows (Equation 8):

$$\begin{aligned}\Delta \mathrm{Ln}APE_t = {} & \varsigma_0 + \varsigma_1 \sum_{i=1}^{k} \Delta \mathrm{Ln}APE_{t-1} + \varsigma_2 \sum_{i=1}^{k} \Delta \mathrm{Ln}PoP_{t-1} + \\ & + \varsigma_3 \sum_{i=1}^{k} \Delta \mathrm{Ln}EPA_{t-1} + \varsigma_4 \sum_{i=1}^{k} \Delta \mathrm{Ln}CP_{t-1} + \\ & + \varsigma_5 \sum_{i=1}^{k} \Delta \mathrm{Ln}FDI_{t-1} + \varsigma_6 \sum_{i=1}^{k} \Delta \mathrm{Ln}CA_{t-1} + \\ & + \varsigma_7 \sum_{i=1}^{k} \Delta \mathrm{Ln}AS_{t-1} + \varsigma_8 \sum_{i=1}^{k} \Delta \mathrm{Ln}AM_{t-1} + \\ & + \eta ECT_{t-1} + \varepsilon_t\end{aligned} \tag{8}$$

https://doi.org/10.17221/252/2020-AGRICECON

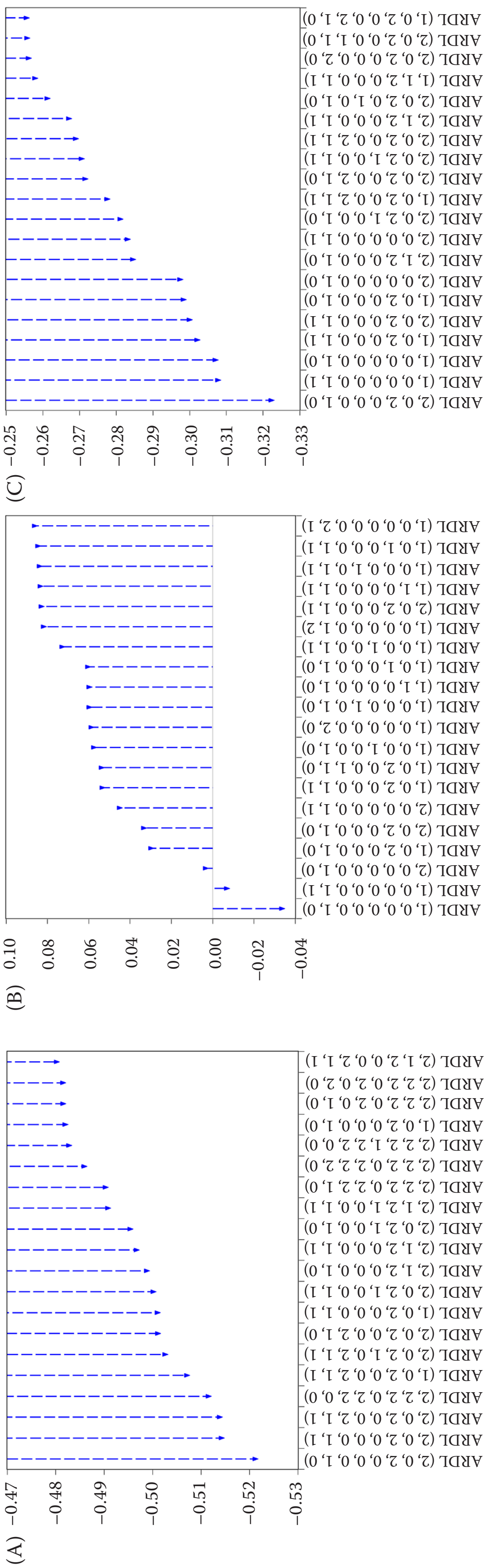

Figure 2. Lag length order selection by (A) Akaike's information criteria, (B) Schwarz criteria, and (C) Hannan-Quinn criterion

Source: Author extracted using EViews (version 9.0), for data source have a review of Table 1

where: *APE* – agricultural products export; *PoP* – total population; *EPA* – employment in agriculture; *CP* – crop production; *FDI* – foreign direct investment; *CA* – credit to agriculture; *AS* – area sown in agriculture; *AM* – the agricultural machinery; *i* – lag; *k* – regressors; ς – short-run relationship; η – the coefficient of the error correction term (*ECT*) in the projected model that interprets the adjustment speed to reverse towards the long-term equilibrium; $\varepsilon_t$ – the white noise error term.

**The VECM Granger causality approach.** All of the above estimates are applicable if a short- or long-term relationship exists between the variables in the ARDL-bound testing approach. However, it does not obviously drift the causal connection between the desired variables. Therefore, the prompt of co-integrating persists; in the following stage the Granger causality between the variables is investigated. Based on the probability of historic and present values in the series, this test observes the causative effect from one variable to another. To expedite the process, causatives and Granger causality were evaluated by a vector error correction model (VECM) for short-term analysis (Engle and Granger 1987). In this context, if variables are mutually cointegrated in a VECM model over the long term, at that instant, short-term causal analysis should have an error correction term ($ECT_{-1}$). In this model, attaining the speed of adjustment needed for attaining the real symmetric position over the long term is challenging. However, if the VECM model estimates showed no cointegration, then we employed the vector autoregressive (VAR) approach to analyse the short-term causality. Thus, the standard form of the VECM for examining the causal connections among the study variables is compiled as Equation (9).

Equation (9) shows the causality test for the VECM model, where Δ represents the difference operator, λ is an error-based term, the long-term linking estimation is represented by $ECT_{t-1}$ (error correction term), and θ represents its coefficient. If θ has a probability significance of < 0.05 and a negative coefficient, it indicates the development of long-term relationships among the study variables. For investigating the Granger causality relationship over the short term, we discuss *F*-statistics based on Wald statistical values.

**Data sources and descriptive statistics.** In this study, annual time series data was used at a macro level for the period 1976–2016. The data was collected from annually published books from the Economic Survey of Pakistan (GOP 2018), the World Development Indicator (WDI 2018), and the Food and Agriculture

https://doi.org/10.17221/252/2020-AGRICECON

$$APE_t = f\left(PoP_t\ EPA_t\ CP_t\ FDI_t\ CA_t\ AS_t\ AM_t\right)$$

$$\begin{bmatrix} \Delta APE \\ \Delta PoP \\ \Delta EPA \\ \Delta CP \\ \Delta FDI \\ \Delta CA \\ \Delta AS \\ \Delta AM \end{bmatrix} = \begin{bmatrix} \pi 1 \\ \pi 2 \\ \pi 3 \\ \pi 4 \\ \pi 5 \\ \pi 6 \\ \pi 7 \\ \pi 8 \end{bmatrix} + \begin{bmatrix} \alpha 11,1 & \alpha 12,1 & \alpha 13,1 & \alpha 14,1 & \alpha 15,1 & \alpha 16,1 & \alpha 17,1 & \alpha 18,1 \\ \alpha 21,1 & \alpha 22,1 & \alpha 23,1 & \alpha 24,1 & \alpha 25,1 & \alpha 26,1 & \alpha 27,1 & \alpha 28,1 \\ \alpha 31,1 & \alpha 32,1 & \alpha 33,1 & \alpha 34,1 & \alpha 35,1 & \alpha 36,1 & \alpha 37,1 & \alpha 38,1 \\ \alpha 41,1 & \alpha 42,1 & \alpha 43,1 & \alpha 44,1 & \alpha 45,1 & \alpha 46,1 & \alpha 47,1 & \alpha 48,1 \\ \alpha 51,1 & \alpha 52,1 & \alpha 53,1 & \alpha 54,1 & \alpha 55,1 & \alpha 56,1 & \alpha 57,1 & \alpha 58,1 \\ \alpha 61,1 & \alpha 62,1 & \alpha 63,1 & \alpha 64,1 & \alpha 65,1 & \alpha 66,1 & \alpha 67,1 & \alpha 68,1 \\ \alpha 71,1 & \alpha 72,1 & \alpha 73,1 & \alpha 74,1 & \alpha 75,1 & \alpha 76,1 & \alpha 77,1 & \alpha 78,1 \\ \alpha 81,1 & \alpha 82,1 & \alpha 83,1 & \alpha 84,1 & \alpha 85,1 & \alpha 86,1 & \alpha 87,1 & \alpha 88,1 \end{bmatrix},$$

$$\begin{bmatrix} \Delta APE_{t-1} \\ \Delta PoP_{t-1} \\ \Delta EPA_{t-1} \\ \Delta CP_{t-1} \\ \Delta FDI_{t-1} \\ \Delta CA_{t-1} \\ \Delta AS_{t-1} \\ \Delta AM_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \alpha 11,1 & \alpha 12,1 & \alpha 13,1 & \alpha 14,1 & \alpha 15,1 & \alpha 16,1 & \alpha 17,1 & \alpha 18,1 \\ \alpha 21,1 & \alpha 22,1 & \alpha 23,1 & \alpha 24,1 & \alpha 25,1 & \alpha 26,1 & \alpha 27,1 & \alpha 28,1 \\ \alpha 31,1 & \alpha 32,1 & \alpha 33,1 & \alpha 34,1 & \alpha 35,1 & \alpha 36,1 & \alpha 37,1 & \alpha 38,1 \\ \alpha 41,1 & \alpha 42,1 & \alpha 43,1 & \alpha 44,1 & \alpha 45,1 & \alpha 46,1 & \alpha 47,1 & \alpha 48,1 \\ \alpha 51,1 & \alpha 52,1 & \alpha 53,1 & \alpha 54,1 & \alpha 55,1 & \alpha 56,1 & \alpha 57,1 & \alpha 58,1 \\ \alpha 61,1 & \alpha 62,1 & \alpha 63,1 & \alpha 64,1 & \alpha 65,1 & \alpha 66,1 & \alpha 67,1 & \alpha 68,1 \\ \alpha 71,1 & \alpha 72,1 & \alpha 73,1 & \alpha 74,1 & \alpha 75,1 & \alpha 76,1 & \alpha 77,1 & \alpha 78,1 \\ \alpha 81,1 & \alpha 82,1 & \alpha 83,1 & \alpha 84,1 & \alpha 85,1 & \alpha 86,1 & \alpha 87,1 & \alpha 88,1 \end{bmatrix}, \quad (9)$$

$$\begin{bmatrix} \Delta APE_{t-k} \\ \Delta PoP_{t-k} \\ \Delta EPA_{t-k} \\ \Delta CP_{t-k} \\ \Delta FDI_{t-k} \\ \Delta CA_{t-k} \\ \Delta AS_{t-k} \\ \Delta AM_{t-k} \end{bmatrix} + \begin{bmatrix} \theta 1 \\ \theta 2 \\ \theta 3 \\ \theta 4 \\ \theta 5 \\ \theta 6 \\ \theta 7 \\ \theta 8 \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \lambda 1 \\ \lambda 2 \\ \lambda 3 \\ \lambda 4 \\ \lambda 5 \\ \lambda 6 \\ \lambda 7 \\ \lambda 8 \end{bmatrix}$$

where: *APE* – agricultural products export; *PoP* –the total population; *EPA* – employment in agriculture; *CP* – crop production; *AS* – the area sown in agriculture; *AM* – the agricultural machinery; *t* – the time period; *k* – regressors

Organization (FAOSTAT 2017), sources shown in Table 1. The descriptive statistics for all study variables are provided in Table 2. The selected variables are used in logarithmic form in the study.

## RESULTS AND DISCUSSION

This section provides empirical estimation of the analysis and for the correlation matrix [Table S1 in electronic supplementary material (ESM); for ESM see the electronic version].

**Estimation of unit root.** The unit root test estimations of both the ADF and PP were conducted via the unit root test approach recognized by Dickey and Fuller (1979) and Phillips and Perron (1988) (Table 3). The outcomes of these tests show that some of the study variables are stationary at level *I* (0), and some are stationary at 1st difference *I* (1), which supports the application of the ARDL model for further analysis.

**ARDL-bounds testing.** For the confirmation of a cointegration association between socioeconomic factors (*PoP, EPA, CP, FDI, CA, AS,* and *AM*) and *APE*, the ARDL-bound testing technique was used. The values of the critical bounds for both the sample's large and small sizes are assumed based on (Pesaran et al. 2001; Narayan 2005). The results of the ARDL-bound testing are reported in Table 4; the values of the $H_0$ hypothesis $H_{APE}$ (*PoP/EPA, CP, FDI, CA, AS, AM*), $H_{PoP}$ (*EPA/CP, FDI, CA, AS, AM, APE*), $H_{EPA}$ (*CP/FDI, CA, AS, AM, APE, PoP*), $H_{FDI}$ (*CA/AS, AM, APE, PoP, EPA, CP*), $H_{AS}$ (*AM/APE, PoP, EPA, CP, FDI, CA*), and $H_{AM}$ (*APE/PoP,*

https://doi.org/10.17221/252/2020-AGRICECON

Table 1. Details of the variables and data source

| Variable | Abbreviation | Unit | Data source |
|---|---|---|---|
| Agricultural products export | *APE* | USD 1 000 | FAOSTAT (2017) |
| Population total | *PoP* | actual figure | FAOSTAT (2017) |
| Employment in agriculture | *EPA* | 1 000 person | FAOSTAT (2017) |
| Cereal production | *CP* | metric tons | WDI (2018) |
| Foreign direct investment | *FDI* | USD | WDI (2018) |
| Credit to agriculture | *CA* | million USD | GOP (2018) |
| Area sown | *AS* | 1 000 ha | FAOSTAT (2017) |
| Agricultural machinery | *AM* | actual figure | FAOSTAT (2017) |

*AM* – the agricultural machinery; *APE* – agricultural products export; *AS* – area sown in agriculture; *CA* – credit to agriculture; *CP* – crop production; *EPA* – employment in agriculture; *FDI* – foreign direct investment; *PoP* – the total population

Source: Authors collected from FAOSTAT (2017), WDI (2018) and GOP (2018)

Table 2. Descriptive statistics results

| Variables | Ln*APE* | Ln*PoP* | Ln*EPA* | Ln*CP* | Ln*FDI* | Ln*CA* | Ln*AS* | Ln*AM* |
|---|---|---|---|---|---|---|---|---|
| Mean | 13.747 | 18.615 | 9.708 | 17.041 | 19.747 | 6.931 | 10.497 | 12.479 |
| Median | 13.549 | 18.651 | 9.634 | 17.044 | 19.858 | 6.689 | 10.495 | 12.681 |
| Maximum | 14.947 | 19.079 | 10.126 | 17.578 | 22.444 | 8.813 | 10.558 | 13.237 |
| Minimum | 12.847 | 18.046 | 9.364 | 16.473 | 15.922 | 5.120 | 10.468 | 10.799 |
| SD | 0.621 | 0.3077 | 0.213 | 0.325 | 1.604 | 0.913 | 0.019 | 0.653 |
| Skewness | 0.354 | –0.263 | 0.328 | 0.021 | –0.376 | 0.168 | 0.781 | –0.901 |
| Kurtosis | 1.915 | 1.884 | 1.893 | 1.815 | 2.517 | 2.346 | 3.958 | 2.929 |
| Jarque-Bera | 13.747 | 18.615 | 9.708 | 17.041 | 19.747 | 6.931 | 10.497 | 12.479 |
| Probability | 0.2385 | 0.272 | 0.243 | 0.301 | 0.505 | 0.630 | 0.056 | 0.061 |

*AM* – the agricultural machinery; *APE* – agricultural products export; *AS* – area sown in agriculture; *CA* – credit to agriculture; *CP* – crop production; *EPA* – employment in agriculture; *FDI* – foreign direct investment; *PoP* – the total population; SD – standard deviation

Source: Authors analyzed by EViews (version 9.0), for data source have a review of Table 1

*EPA, CP, FDI, CA, AS*) are 4.47, 13.07, 4.71, 5.37, 7.77 and 8.73, respectively, above the upper bound value at 5% and 1% significance levels. The value of $H_{CA}$ (*AS/AM, APE, PoP, EPA, CP, FDI*) is 2.99 above the upper bound at a 10% significance level. These results show that a long-term equilibrium relationship exists among all variables. However, the value of $H_{CP}$ (*FDI/CA, AS, AM, APE, PoP, EPA*) is 0.95 under the lower bound at a 10% significance level; however, if *CP* is a dependent variable, the results show no integrating relationship.

The estimated results of the ARDL-bound testing confirm seven long-term associations between socioeconomic factors (*PoP, EPA, CP, FDI, CA, AS, AM*) and *APE* growth in Pakistan. Additionally, the Johansen cointegration technique along with the maximum eigenvalue and trace test is used to find the strength of long-term cointegration associations between variables, and the estimated results are presented in Table 5. These findings indicated that, in trace statistics, cointegrations Coin ≤ 0 Coin ≤ 1 and Coin ≤ 2 are significant at 1%, Coin ≤ 3 is significant at 5%, and the others are non-significant. In the maximum Eigen statistics, Coin ≤ 0 and Coin ≤ 1 are significant at 1%, Coin ≤ 3 is significant at 5%, and the others are non-significant. This indicates the existence of a long-term relationship among the dependent and independent variables and supports the rejection of the null hypothesis at the 1% and 5% significance levels. The selection of a probability value measurement was based upon MacKinnon et al. (1999).

**Long-term and short-term analysis.** The results of the long-term and short-term associations between socioeconomic factors (*PoP, EPA, CP, FDI, CA, AS, AM*) and *APE* are shown in Table 6. According to the results, there is surprisingly no long-term relationship between agricultural production and other explanatory variable, and no previously published paper has used the same

https://doi.org/10.17221/252/2020-AGRICECON

Table 3. Results of Augmented Dickey-Fuller and Phillip-Perron based on the unit root test

| Variables | Level | | 1st difference | | Outcome |
|---|---|---|---|---|---|
| | intercept | trend and intercept | intercept | trend and intercept | |
| **Augmented Dickey fuller** | | | | | |
| Ln*AM* | –2.482 | –4.460** | –2.186 | –2.591 | *I* (0) |
| Ln*PoP* | –0.245 | –2.925 | –8.123*** | –8.040*** | *I* (1) |
| Ln*EPA* | –0.629 | –6.147*** | –11.363*** | –11.210*** | *I* (0)/*I* (1) |
| Ln*CP* | –2.252 | –3.477 | –5.130*** | –5.124*** | *I* (I) |
| Ln*FDI* | –0.433 | –1.381 | –4.289** | –4.222** | *I* (1) |
| Ln*CA* | 6.579*** | –4.09** | –4.125** | –5.356*** | *I* (0)/*I* (1) |
| Ln*AS* | –4.216** | –4.163** | –12.627*** | –4.879** | *I* (0)/*I* (1) |
| Ln*APE* | –0.451 | –4.018** | –7.666*** | –7.555*** | *I* (0)/*I* (1) |
| **Phillip-Perron** | | | | | |
| Ln*AM* | –8.997*** | –1.296 | –0.403 | –2.154 | *I* (0) |
| Ln*PoP* | 0.907 | –2.913 | –10.393*** | –13.307*** | *I* (1) |
| Ln*EPA* | –0.593 | –6.147*** | –15.738*** | –15.487*** | *I* (0)/*I* (1) |
| Ln*CP* | –2.219 | –2.960 | –5.126*** | –5.124*** | *I* (1) |
| Ln*FDI* | –0.630 | –1.836 | –4.260** | –4.189** | *I* (1) |
| Ln*CA* | –6.597*** | -4.189** | –4.156** | –5.338*** | *I* (0)/*I* (1) |
| Ln*AS* | –3.897** | –4.097** | –11.486*** | –11.366*** | *I* (0)/*I* (1) |
| Ln*APE* | –1.090 | –4.058** | –11.907*** | –11.843*** | *I* (0)/*I* (1) |

***Acquired null hypothesis rejected at 1% level; ** reject the null hypothesis as 5% significant level; *AM* – the agricultural machinery; *APE* – agricultural products export; *AS* – area sown in agriculture; *CA* – credit to agriculture; *CP* – crop production; *EPA* – employment in agriculture; *FDI* – foreign direct investment; *PoP* – the total population

Source: Results in author calculation by using EViews (version 9.0), for data source have a review of Table 1

Table 4. Results of autoregressive distributed lag-bounds testing

| Variables | *F*-statistics | *K* |
|---|---|---|
| $H_{APE}$ (*PoP/EPA, CP, FDI, CA, AS, AM*) | 4.47 | |
| $H_{PoP}$ (*EP/CP, FDI, CA, AS, AM, APE*) | 13.07 | |
| $H_{EPA}$ (*CP/FDI, CA, AS, AM, APE, PoP*) | 4.71 | |
| $H_{CP}$ (*FDI/CA, AS, AM, APE, PoP, EPA*) | 0.95 | 7 |
| $H_{FDI}$ (*CA/AS, AM, APE, PoP, EPA, CP*) | 5.37 | |
| $H_{CA}$ (*AS/AM, APE, PoP, EPA, CP, FDI*) | 2.99 | |
| $H_{AS}$ (*AM/APE, PoP, EPA, CP, FDI, CA*) | 7.77 | |
| $H_{AM}$ (*APE/PoP, EPA, CP, FDI, CA, AS*) | 8.73 | |
| **Critical value (%)** | lower bound | upper bound |
| 10 | 1.92 | 2.89 |
| 5 | 2.17 | 3.21 |
| 2.5 | 2.43 | 3.51 |
| 1 | 2.73 | 3.9 |

*AM* – the agricultural machinery; *APE* – agricultural products export; *AS* – area sown in agriculture; *CA* – credit to agriculture; *CP* – crop production; *EPA* – employment in agriculture; *FDI* – foreign direct investment; *K* – number of regressors; *PoP* – the total population

Source: Results in author calculation by using EViews (version 9.0), for data source have a review of Table 1

variables for the same time period. However, a relationship between the selected variables is possible because of the cultivated area, agricultural inputs, and crop production changes due to the increasing population and time trend (Zulfiqar and Thapa 2017; Ullah et al. 2020). Javed et al. (2019) found that Pakistan's agricultural exports

https://doi.org/10.17221/252/2020-AGRICECON

Table 5. Multivariate co-integration approach

| Hypothesized number of CE(s) | Eigen value | Trace test | Significance level | |
|---|---|---|---|---|
| | | | critical value at 5% | critical value at 1% |
| **Trace test** | | | | |
| Coin ≤ 0 | 0.925 | 274.318 | 159.529*** | 171.090*** |
| Coin ≤ 1 | 0.753 | 173.321 | 125.615*** | 135.972*** |
| Coin ≤ 2 | 0.625 | 118.796 | 95.753*** | 104.961*** |
| Coin ≤ 3 | 0.605 | 80.577 | 69.818** | 77.819** |
| Coin ≤ 4 | 0.476 | 44.295 | 47.856 | 54.682 |
| Coin ≤ 5 | 0.231 | 19.071 | 29.797 | 35.458 |
| Coin ≤ 6 | 0.201 | 8.803 | 15.494 | 19.937 |
| Coin ≤ 7 | 9.510 | 0.004 | 3.841 | 6.635 |
| **Maximum eigenvalue test** | | | | |
| Coin ≤ 0* | 0.924 | 100.997 | 52.362 | 58.668*** |
| Coin ≤ 1* | 0.752 | 54.525 | 46.231 | 52.308*** |
| Coin ≤ 2* | 0.624 | 38.217 | 40.077 | 45.869 |
| Coin ≤ 3* | 0.605 | 36.281 | 33.876 | 39.370** |
| Coin ≤ 4 | 0.476 | 25.224 | 27.584 | 32.715 |
| Coin ≤ 5 | 0.231 | 10.268 | 21.131 | 25.861 |
| Coin ≤ 6 | 0.201 | 8.810 | 14.264 | 18.520 |
| Coin ≤ 7 | 9.510 | 0.004 | 3.841 | 6.635 |

***Acquired null hypothesis rejected at 1% level, **reject the null hypothesis at 5% significant level; CE – co-integration equation; Coin – cointegration

Source: Results in author calculation by using EViews (version 10), for data source have a review of Table 1

can significantly improve if the international export value chain and business tides are improved.

In terms of short-term relationships, results show that the area sown (*AS*) has a positive and significant correlation with agricultural products export (*APE*). An increase of 1% in the area sown will result in an increase of 1.963% in agricultural products export. The results regarding cereal production (*CP*) also contradict the null hypothesis, with a positive coefficient and a 10% significance level, which indicates that a 10% increase in crop production will significantly improve agricultural products export by 1.051%, These results are consistent with Mirza et al. (2016) and Han and Chen (2018) in China. Mirza et al. (2016) analysed Pakistan's cash crop export trends from 1980 to 2009 and concluded that increases in the area sown with cash crops and increases in crop production will significantly increase cash crop exports. In addition, in Table 6, we can see that other variables support the null hypothesis and contradict the null hypothesis, with a positive coefficient and no significance. It could be because population and employment in agriculture do not directly influence agricultural products export in the short term, but indirectly influence them in the long term. It is evident that increases in population will cause an increasing trend in urbanization, employment, and food demand, which will ultimately affect agricultural commodity exports (Hashmi 2011; Wu et al. 2018; Rehman et al. 2019a). The results of the error correct term ($ECT_{-1}$) support rejections of the null hypothesis and supports an alternative hypothesis with a negative coefficient and a 1% significant level. This indicates the speed of the movement of agricultural products export toward a long-term equilibrium in a short period of time.

**Diagnostic tests.** To determine the goodness-of-fit of the ARDL model, we performed several diagnostics tests. The stability of the model is shown in the autoregressive (AR) root graph in Figure 3. The results of serial correlation, the normality test, and heteroskedasticity show that the value of the *F*-state is positive and non-significant, supporting the null hypothesis instead of rejecting an alternative hypothesis (Table 7). Furthermore, the diagnostic tests confirm the stability of the good fit model.

**Robustness tests.** Cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) tests were also utilized in this empirical study to check the stability of the structures in the ARDL model. Figure 4 shows that both the CUSUM and CUSUMSQ plots fall within the limits of a 5% significance level, favour-

https://doi.org/10.17221/252/2020-AGRICECON

Table 6. Long-run and short-run association among desired variables

| Variables | Coefficient | SE | *t*-statistic | *P*-value |
|---|---|---|---|---|
| **Long run association** | | | | |
| *C* | –37.949 | 19.136 | –1.983 | 0.056* |
| Ln*PoP* | 0.771 | 0.938 | 0.821 | 0.417 |
| Ln*EPA* | 0.785 | 0.856 | 0.917 | 0.366 |
| Ln*CP* | 0.879 | 0.685 | 1.284 | 0.208 |
| Ln*FDI* | –0.072 | 0.059 | –1.214 | 0.233 |
| Ln*CA* | 0.195 | 0.123 | 1.598 | 0.119 |
| Ln*AS* | 1.703 | 1.700 | 1.001 | 0.324 |
| Ln*AM* | –0.246 | 0.258 | –0.955 | 0.347 |
| **Short run association** | | | | |
| Ln*APE* | –56.111 | 19.130 | 2.933 | 0.000*** |
| Ln*PoP* | 0.633 | 1.099 | 0.581 | 0.565 |
| Ln*EPA* | 0.462 | 0.806 | 0.572 | 0.571 |
| Ln*CP* | 1.051 | 0.599 | 1.782 | 0.086* |
| Ln*FDI* | –0.076 | 0.059 | –1.299 | 0.205 |
| Ln*CA* | 0.163 | 0.117 | 1.397 | 0.174 |
| Ln*AS* | 1.963 | 0.663 | 2.960 | 0.006** |
| Ln*AM* | 2.063 | 1.864 | 1.534 | 0.137 |
| $ECT_{(-1)}$ | –0.986 | 0.053 | –18.374 | 000*** |
| $R^2$ | 0.949 | Akaike information criterion | | –0.521 |
| Adjusted $R^2$ | 0.926 | Schwarz criterion | | –0.033 |
| *F*-statistic | 41.117 | Hannan-Quinn criteria | | –0.322 |
| Probability | 0.000 | DW | | 1.860 |

***Acquired null hypothesis rejected at 1% level, **reject the null hypothesis as 5% significant level, *reject the null hypothesis at 10% significance level; *AM* – the agricultural machinery; *APE* – agricultural products export; *AS* – area sown in agriculture; *C* – constant; *CA* – credit to agriculture; *CP* – crop production; DW – Durbin Watson; *EPA* – employment in agriculture; *ECT* – error correction term; *FDI* – foreign direct investment; *PoP* – the total population; *R* – residual square; SE – standard error
Source: Results in author calculation by using EViews (version 9.0), for data source have a review of Table 1

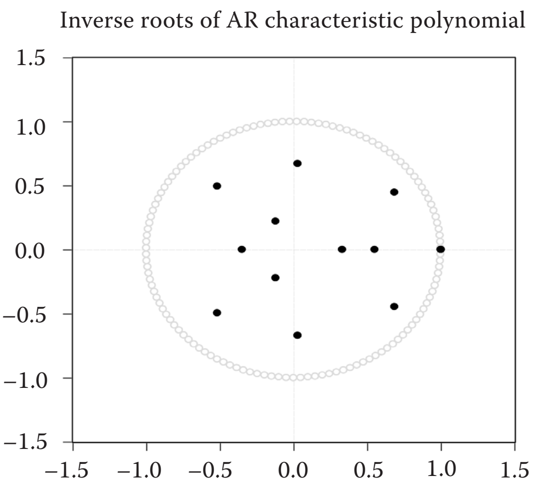


Figure 3. Autoregressive inverse root graph based on stability test

AR – the autoregressive root
Source: Author's extracted using EViews (version 9.0), for data source have a review of Table 1

ing the constancy of variables. Therefore, the ARDL model and parallel limits for socio-economic factors (*PoP, EPA, CP, FDI, CA, AS, AM*) and *APE* growth in Pakistan are adequately reliable. The same stability tests have been applied by a number of researchers for model stability and goodness-of-fit (Ploberger and Krämer 1992; Huang et al. 2011; Rehman et al. 2019b; Koondhar et al. 2020).

**Granger causality analysis in the VECM context.** In Table 8, the results of VECM Granger causality can

Table 7. Diagnostic test results

| Residual diagnostic tests | *F*-statistic | *P*-value |
|---|---|---|
| Normality | 0.370 | 0.830 |
| Serial correlation LM | 3.200 | 0.061 |
| Heteroskedasticity | 0.935 | 0.542 |

LM – lagrange multiplier
Source: Analyzed by the author using EViews (version 9.0), for data source have a review of Table 1

https://doi.org/10.17221/252/2020-AGRICECON

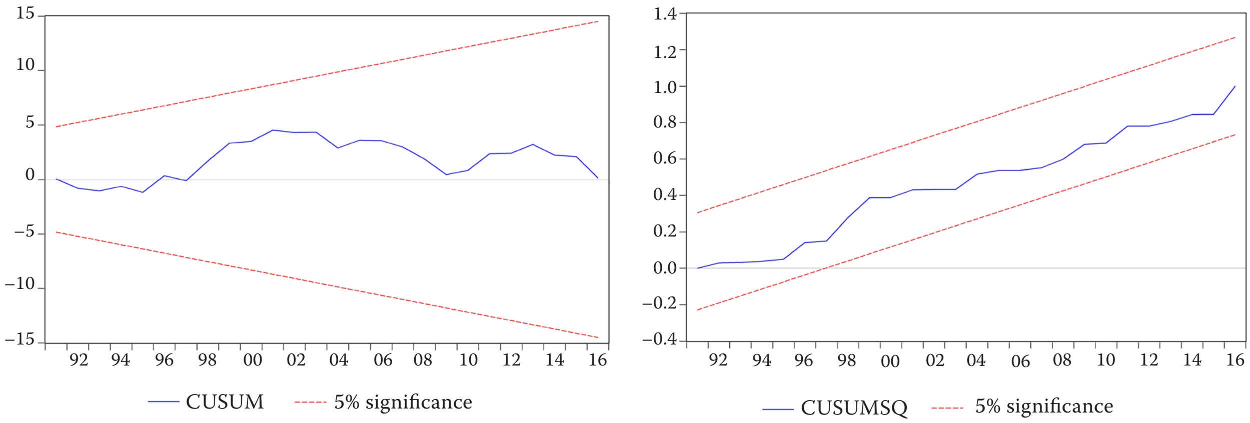


Figure 4. Results of cumulative sum (CUSUM) and cumulative sum of the square (CUSUMSQ) test
Source: Author's extracted using EViews (version 9.0), for data source have a review of Table 1

indicate the directional causal connection between study variables. According to the results, *CP* Granger-causes *APE* and has a unidirectional relationship, i.e. *CP* affects *APE*, while *APE* does not affect *CP*. One study conducted by Balogh and Jambor (2020) revealed that crop production influences agricultural product trade, and the quality of those agricultural products has a significant and positive influence on agricultural trade. Another study concluded that the production of major cereal crops in Pakistan helps to improve the contribution of agriculture to GDP (Ali et al. 2020). It also showed that *APE* and *FDI* Granger-causes *PoP*, with coefficients 5.467 and 6.254, respectively. An increasing population rate may result in land fragmentation, which can significantly influence agricultural production and ultimately impacts *APE* (Bhutto and Bazmi 2007). *EPA* Granger-causes *APE* and exhibits a bidirectional association. The direction of *EPA* to *APE* and *APE* to *EPA* is positive.

**Impulse response function.** In order to obtain information regarding the associations amongst the variables, the impulse response function was employed. This phenomenon analyses the future effects of shocks. Figure 5 presents the combined responses amongst

Table 8. Vector error correction model Granger causality/block exogeneity Wald tests

| Dependent variables | Independent variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ln*APE* | Ln*PoP* | Ln*EPA* | Ln*CP* | Ln*FDI* | Ln*CA* | Ln*AS* | Ln*AM* |
| Ln*APE* | – | 5.467 (0.002)** | 5.364 (0.002)** | 0.281 (0.887) | 2.249 (0.089) | 0.051 (0.994) | 2.604 (0.057) | 1.698 (0.178) |
| Ln*PoP* | 3.999 (0.010) | – | 1.684 (0.144) | 1.452 (0.243) | 2.199 (0.094) | 0.246 (0.909) | 1.505 (0.550) | 1.904 (0.354) |
| Ln*EPA* | 5.801 (0.001)** | 0.519 (0.722) | – | 2.903 (0.039) | 0.953 (0.145) | 0.953 (0.448) | 1.021 (0.413) | 0.220 (0.924) |
| Ln*CP* | 4.511 (0.006)** | 0.684 (0.608) | 1.706 (0.176) | – | 1.755 (0.165) | 0.420 (0.792) | 3.001 (0.035) | 2.102 (0.120) |
| Ln*FDI* | 1.361 (0.272) | 6.254 (0.001)** | 0.861 (0.145) | 0.887 (0.484) | – | 1.306 (0.291) | 1.897 (0.138) | 2.873 (0.041) |
| Ln*CA* | 1.383 (0.265) | 0.593 (0.670) | 0.959 (0.444) | 1.348 (0.276) | 1.090 (0.380) | – | 0.648 (0.633) | 3.144 (0.029) |
| Ln*AS* | 1.718 (0.173) | 0.550 (0.700) | 0.386 (0.816) | 0.905 (0.474) | 1.726 (0.380) | 0.292 (0.880) | – | 1.671 0.184 |
| Ln*AME* | 3.406 (0.021) | 1.148 (0.354) | 1.399 (0.259) | 0.522 (0.720) | 0.963 (0.442) | 1.983 (0.124) | 0.379 (0.821) | – |

***Acquired null hypothesis rejected at 1% level, **reject the null hypothesis as 5% significant level; *AM* – the agricultural machinery; *APE* – agricultural products export; *AS* – area sown in agriculture; *CA* – credit to agriculture; *CP* – crop production; *EPA* – employment in agriculture; *FDI* – foreign direct investment; *PoP* – the total population
Source: Results in author calculation by using EViews (version 9.0), for data source have a review of Table 1

https://doi.org/10.17221/252/2020-AGRICECON

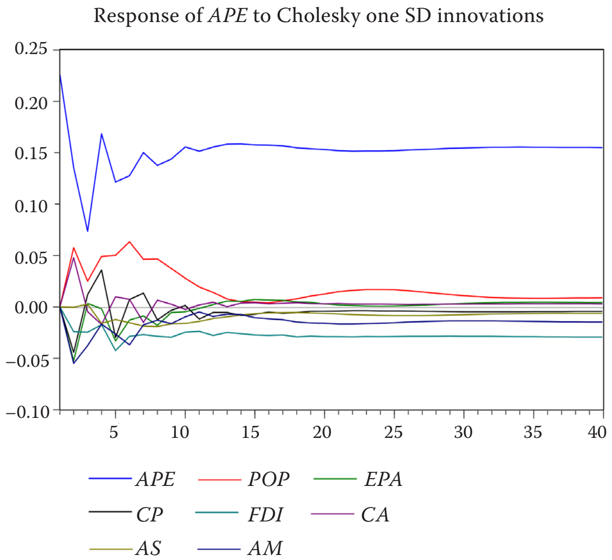


Figure 5. Results of the impulse response function

*AM* – the agricultural machinery; *APE* – agricultural products export; *AS* – area sown in agriculture; *CA* – credit to agriculture; *CP* – crop production; *EPA* – employment in agriculture; *FDI* – foreign direct investment; *PoP* – the total population; SD – standard deviation

Source: Author's extracted using EViews (version 9.0), authors collected from FAOSTAT (2017), WDI (2018) and GOP (2018)

the variables. The results show that the *APE* variable experiences a zigzag trend due to a 1st standard derivation shock by another explanatory variable along with the time trend. Over a 15-years history, all the variables and *APE* both show a flat trend and an ascendant inclination. A similar trend is followed amongst the other variables, but with different inclinations. This same technique was used in early research to find a serial correlation (Koondhar et al. 2020).

## CONCLUSION AND POLICY IMPLICATIONS

This study estimated the causal correlation between agricultural products export and possible influencing factors in Pakistan using annual time series data and an ARDL model for the period 1976–2016. Results show that all the desired variables were stationary at the level and 1st difference. Additionally, the cointegration test showed that there is a long-term relationship among the dependent and independent variables and supported the rejection of the null hypothesis, rather than its acceptance, at 1% and 5% significance levels. The results of the ARDL model do not show long-term associations among the desired variables, but do show a short-term association between the area sown and agricultural products export. The speed of adjustment towards a long-term equilibrium over a short period of time was confirmed by $ECT_{-1}$.

The results indicate that a 10% increase in cereal production and a 5% increase in area sown causes an increase of 1.05% and 1.96% in agricultural products export respectively. This will not only solve food insecurity but will also increase exports in Pakistan. Furthermore, the goodness-of-fit model was confirmed by the robustness tests.

Based on the findings, key policy implications emerged. Firstly, the government of Pakistan should emphasize policies related to land consolidation in order to cultivate more agricultural area and improve agricultural production, ensuring a healthy environment and a high quality of agricultural products to be exported. Furthermore, the government of Pakistan should implement policies supporting the adoption of innovative technologies that improve farm production efficiency, lead to efficient land utilization, secure the livelihood of farmers. To improve agricultural products export, the government of Pakistan needs to find new international markets where there is demand for the bulk production of such agricultural products export as cotton and rice. When China closed the borders to prevent the spread of COVID-19, Pakistan's textile export increased to 13.82%. Therefore, this study also recommends that the government of Pakistan help farmers to improve the quality of cotton and provide a sustainable value chain for improving agricultural exports. To introduce Pakistani agricultural products, the government of Pakistan needs to officially organize and actively participate in international exhibitions. Pakistan should facilitate exporters by reducing cross-border taxes on agricultural products and provide visa facilities.

## REFERENCES


Ahmad D., Afzal M., Khan U.G. (2017): Impact of exports on economic growth empirical evidence of Pakistan. International Journal of Applied Economic Studies, 5: 9.

Ahmad K.F.Z., Muhammad S., Ul H.M., Tahira G.H., Feehan H., Aamir M.S. Atif W. (2013): Agricultural dynamics in Pakistan: Current issues and solutions. Russian Journal of Agricultural and Socio-Economic Sciences, 20: 20–26.

Ahmad N. (2011): Impact of institutional credit on agricultural output. Theoretical and Applied Economics, 42: 469–485.

Akinbode S.O., Ojo O.T. (2017): Exchange rate volatility and agricultural exports in Nigeria: an autoregressive distributed lag (ARDL) bound test approach. Annual NAAE Conference. Abeokuta, Nigeria, Oct 16–19, 2020:

https://doi.org/10.17221/252/2020-AGRICECON

Akram W., Hussain Z., Sabir H.M., Hussain I. (2008): Impact of agricultural credit on growth and poverty in Pakistan (time series analysis through error correction model). European Journal of Scientific Research, 23: 243–251.

Ali I., Khan I., Ali H., Baz K., Zhang Q., Khan A., Huo X. (2020): Does cereal crops asymmetrically affect agriculture gross domestic product in Pakistan? Using NARDL model approach. Ciência Rural, 50: 1–12.

Atif R.M., Haiyun L., Mahmood H. (2017): Pakistan's agricultural exports, determinants and its potential: an application of stochastic frontier gravity model. The Journal of International Trade & Economic Development, 26: 257–276.

Aurino E. (2017): The State of Food and Agriculture Leveraging Food Systems for Inclusive Rural Transformation. Rome, Food and Agriculture Organization of the United Nations.

Baek J., Koo W.W. (2009): Assessing the exchange rate sensitivity of US bilateral agricultural trade. Canadian Journal of Agricultural Economics, 57: 187–203.

Bakari S., Sofien T. (2019): Does Agricultural trade promote Chinese economic growth? ARDL Approach. Tunisia, University of Tunis El Manar. Paper No. 94614.

Balogh J.M., Jámbor A. (2020): The environmental impacts of agricultural trade: A systematic literature review. Sustainability, 12: 1152.

Bhatti A.M., Suttinon P., Nasu S. (2009): Agriculture water demand management in Pakistan: A review and perspective. Society for Social Management Systems, 9: 1–7.

Bhutto A.W., Bazmi A.A. (2007): Sustainable agriculture and eradication of rural poverty in Pakistan. In: Natural Resources Forum. Oxford, Blackwell Publishing Ltd.: 253–262.

Chandio A.A., Mirani A.A., Shar R.U. (2019): Does agricultural sector foreign direct investment promote economic growth of Pakistan? Evidence from cointegration and causality analysis. World Journal of Science, Technology and Sustainable Development, 16: 196–207.

Dickey D.A., Fuller W.A. (1979): Distribution of the estimators for autoregressive time series with a unit root. Journal of The American Statistical Association, 74: 427–431.

Dowlatchahi M.M. (2020): Pakistan at a Glance. Pakistan, Food and Agriculture Organization of the United Nations. Available at http://www.fao.org/pakistan/our-office/pakistan-at-a-glance/en/

Dube A.K., Ozkan B., Govindasamy R. (2018): Analyzing the export performance of the horticultural sub-sector in Ethiopia: ARDL bound test cointegration analysis. Horticulturae, 4: 34.

Engle R.F., Granger C.W. (1987): Co-integration and error correction: representation, estimation, and testing. Econometrica: Journal of the Econometric Society, 55: 251–276.

FAOSTAT (2017): Datasets. Food and Agriculture Organization. Available at: http://www.fao.org/home/en/?

Frankel J.A., Romer D.H. (1999): Does trade cause growth? American Economic Review, 89: 379–399.

GOP (2016): Pakistan Economic Survey. Islamabad, Pakistan, Government of Pakistan, Ministry of Finance.

GOP (2018): Pakistan Economic Survey. Islamabad, Pakistan, Government of Pakistan, Ministry of Finance.

GOP (2019): Population Census 2017. Islamabad, Pakistan, Pakistan Bureau of Statistics.

Han M., Chen G. (2018): Global arable land transfers embodied in Mainland China's foreign trade. Land Use Policy, 70: 521–534.

Hashmi M.S. (2011): Land distribution, technological changes and productivity in Pakistan's agriculture: Some explanations and policy options. Management, 1: 51–74.

Hatemi-J. A., Hacker R.S. (2009): Can the LR test be helpful in choosing the optimal lag order in the VAR model when information criteria suggest different lag orders? Applied Economics, 41: 1121–1125.

Haug A.A. (2002): Temporal aggregation and the power of cointegration tests: A Monte Carlo study. Oxford Bulletin Of Economics And Statistics, 64: 399–412.

Hoffmann U. (2013): Trade and environment review. United Nations Conference on Trade and Development. Geneva, Sept 18, 2013: 341

Huang Y., Li H., Campbell K.A., Han Z. (2011): Defending false data injection attack on smart grid network using adaptive CUSUM test. 45th Annual Conference on Information Sciences and Systems. Baltimore, March 23–25, 2011: 1–6.

Iqbal M., Ahmad M., Abbas K., Mustafa K. (2003): The impact of institutional credit on agricultural production in Pakistan. The Pakistan Development Review, 42: 469–485.

Javed A. (2019): Pakistan's Agriculture Trade with South Asia. Munich Personal RePEc Archive, Sustainable Development Policy Institute. Paper No. 95729: 255–267.

Koondhar M.A., Qiu L., Li H., Liu W., He G. (2018a): A nexus between air pollution, energy consumption and growth of economy: A comparative study between the USA and China-based on the ARDL bound testing approach. Agricultural Economics – Czech, 64: 265–276.

Koondhar M.A., Qiu L., Magsi H., Chandio A.A., He G. (2018b): Comparing economic efficiency of wheat productivity in different cropping systems of Sindh province, Pakistan. Journal of the Saudi Society of Agricultural Sciences, 17: 398–407.

Koondhar M.A., Li H., Wang H., Bold S., Kong R. (2020): Looking back over the past two decades on the nexus between air pollution, energy consumption, and agricultural productivity in China: A qualitative analysis based on the ARDL bounds testing model. Environmental Science and Pollution Research, 27: 13575–13589.

https://doi.org/10.17221/252/2020-AGRICECON

MacKinnon J.G., Haug A.A., Michelis L. (1999): Numerical distribution functions of likelihood ratio tests for cointegration. Journal of Applied Econometrics, 14: 563–577.

Makhmutova D.I., Mustafin A.N. (2017): Impact of international trade on economic growth. International Journal of Scientific Study, 5: 140–144.

Mirza A., Shaikh N., Shaikh P.A., Khan S. (2016): Trends and analysis of Pakistan's cash crops export during 1980–2009. International Journal of Development and Sustainability, 5: 220–232.

Msuya E. (2007): The impact of foreign direct investment on agricultural productivity and poverty reduction in Tanzania. Kyoto, Munich Personal RePEc Archive, Paper No. 3671: 15.

Muchapondwa E. (2008): Estimation of the aggregate agricultural supply response in Zimbabwe: The ARDL approach to cointegration. Cape Town, University of Cape Town, Working Paper No. 90.

Narayan P.K. (2005): The saving and investment nexus for China: Evidence from cointegration tests. Applied Economics, 37: 1979–1990.

Okezie C.A., Sulaiman J., Nwosu A.C. (2012): Farm-level determinants of agricultural commercialization. International Journal of Agriculture and Forestry, 2: 1–5.

Ohlan R. (2013): Agricultural exports and the growth of agriculture in India. Agricultural Economics, 59: 211–218.

Peseran M., Peseran B. (1997): Working with Microfit 4: Interactive Econometric Analysis. Oxford, Oxford University Press.

Pesaran M.H., Shin Y. (1998): An autoregressive distributed-lag modelling approach to cointegration analysis. Econometric Society Monographs, 31: 371–413.

Pesaran M.H., Shin Y., Smith R.J. (2000): Structural analysis of vector error correction models with exogenous I (1) variables. Journal of Econometrics, 97: 293–343.

Pesaran M.H., Shin Y., Smith R.J. (2001): Bounds testing approaches to the analysis of level relationships. Journal of applied econometrics, 16: 289–326.

Phillips P.C., Perron P. (1988): Testing for a unit root in time series regression. Biometrika, 75: 335–346.

Ploberger W., Krämer W. (1992): The CUSUM test with OLS residuals. Econometrica, 60: 271–285.

Raza J., Siddiqui W. (2014): Determinants of agricultural output in Pakistan: A Johansen co-integration approach. Academic Research International, 5: 30.

Rehman A., Jingdong L., Du Y., Khatoon R. (2015a): Banking role and loan schemes for agricultural development in China & Pakistan. Global Journal of Human-Social Science, 15: 7E.

Rehman A., Jingdong L., Shahzad B., Chandio A.A., Hussain I., Nabi G., Iqbal M.S. (2015b): Economic perspectives of major field crops of Pakistan: An empirical study. Pacific Science Review B: Humanities and Social Sciences, 1: 145–158.

Rehman A., Chandio A.A., Hussain I., Jingdong L. (2019a): Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. Journal of the Saudi Society of Agricultural Sciences, 18: 269–274.

Rehman A., Rauf A., Ahmad M., Chandio A.A., Deyuan Z. (2019b): The effect of carbon dioxide emission and the consumption of electrical energy, fossil fuel energy, and renewable energy, on economic performance: evidence from Pakistan. Environmental Science and Pollution Research, 26: 21760–21773.

Salam A. (2012): Review of input and output policies for cereals production in Pakistan. Islamabad, International Food Policy Research Institute, Discussion Paper No. 01223.

Schultz T.W. (1980): Nobel lecture: the economics of being poor. Journal of Political Economy, 88: 639–651.

Shrestha M.B., Bhatta G.R. (2018): Selecting appropriate methodological framework for time series data analysis. The Journal of Finance and Data Science, 4: 71–89.

Siaw A., Jiang Y., Pickson R.B., Dunya R. (2018): Agricultural exports and economic growth: A disaggregated analysis for Ghana. Theoretical Economics Letters, 8: 2251.

Ullah A., Arshad M., Kächele H., Khan A., Mahmood N., Müller K. (2020): Information asymmetry, input markets, adoption of innovations and agricultural land use in Khyber Pakhtunkhwa, Pakistan. Land Use Policy, 90: 104261.

WDI (2018): The World Bank. Washington, World Development Indicators.

Wu X.D., Guo J.L., Han M., Chen G. (2018): An overview of arable land use for the world economy: From source to sink via the global supply chain. Land Use Policy, 76: 201–214.

Zaheer R., Omoregbee F., Ighoro A., Ejembi S., Nandan G., Jangubhai N., Patricia A. (2013): Analyzing the performance of agriculture sector in Pakistan. International Journal of Humanities and Social Science Invention, 2: 1–10.

Zuberi H.A. (1989): Production function, institutional credit and agricultural development in Pakistan. The Pakistan Development Review, 28: 43–55.

Zulfiqar F., Thapa G.B. (2017): Agricultural sustainability assessment at provincial level in Pakistan. Land Use Policy, 68: 492–502.

Received: June 28, 2020
Accepted: November 3, 2020