

PRICE DYNAMICS AND PRODUCTION RESPONSE OF MUNG BEAN PULSES IN PUNJAB, PAKISTAN: EVIDENCE FROM AN ARDL MODEL

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ABSTRACT

Mung bean is a major source of high-quality protein and consumed in different farms such as whole grains and sprouted to balance the human nutrition level in Pakistan. The central theme of this study was to analyze the area and production scenario of mung bean pulses with respect to input and output prices at Punjab-Pakistan. Statistical information on area, production, yield and prices of mung bean along with other major crops (cotton, sugarcane) and input price (DAP and Urea) was obtained for previous 38 years from different secondary sources. The data were analyzed using Autoregressive Distributed Lag (ARDL) bounds testing approach. The estimated results of the study revealed that own prices of mung bean have positive but statistically insignificant impact on its production and inversely related to the prices of other competing crops (cotton and sugarcane). This can be explained by the fact that pulses are considered a risky crop due to yield fluctuations when compared to other competing cereal and cash crops. Price of fertilizer returned a negative sign which indicated that increase in prices of input adversely affected the production of mung bean. Empirical results suggested that mung bean farmers are risk averse and prefer crops with sustained profitability thus there is a strong need of Government support through pulses package in the short run where a buy back guarantees and provision of improved seeds at subsidized prices is ensured. The findings suggest that farmers are risk averse and prefer crops with consistent profitability. Policy support is therefore required in the form of provision of quality seed, assured procurement pricing, and crop insurance schemes to encourage expansion of mung bean cultivation in Punjab-Pakistan

Key Words: Mung Bean, Pulses, Supply Response, ARDL, Prices, Punjab

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INTRODUCTION

Pulses are major source of vegetable protein for the low-income group of people to meet the need of nutrition level of protein from pulses instead of livestock (Dhindsa and Sharma, 1997). Protein content of pulse grains ranges from 15 to 30% while 17-19% in chickpea, 23-31% in lentil and 21-28% in mash. ¹

¹ Cai et al. 2002, Anwar et al. 2007, Kole et al. 2002, Fouad and Rehab 2015, Hall et al. 2016 and Ghumman et al. 2016.

Pulse production is primarily concentrated in low-cropping-intensity locations. This means that their cultivation is typically pushed to less fertile areas that are only marginally productive for grain and cash crops. Farmers' low preference for cropping pulses to avoid the pressure to produce more food and raw materials from land have negative effect on supply of pulse and also pulses production has not benefited from both public as well as private investment in irrigation infrastructure (Ali and Abedullah, 1998). The need for pulses is steadily increasing due to rising population, but supply is unable to keep up with the rising demand (Savadatti, 2018).

The United Nations declared 2016 to be the Global Year of Pulses, and they were proclaimed as nourishing seeds for a maintainable future. Pulses are consumed at a global average of 7 kilograms per person per year (FAO, 2016). Pulses are grown on around 5% of the total planted area. The human consumption of pulses is more than 60% of the production; with average consumption is 4.18 kg per person per year (Kumar and Bourai, 2012). Further, day by day, pulses demand is increasing due rising population. Pakistan is importing large amounts of pulses due to low pulses production and to satisfy the ever-increasing gap between supply and demands (Chaudhry *et al.* 2002). Currently, Pakistan is producing only about 501.9 thousand tonnes of major pulses. The rest of these pulses have to be imported to fulfill the country requirement. Therefore, the import bill of pulses surged by 189.3 percent during 2017-18 (GoP, 2017).

Farm supply response analysis, one of the critical economic factors determining the production decision of farmer is price (Khan and Hussain, 2007). There is a main role of agriculture pricing policy in enhancing both agricultural output as well as income, and supply response is a base to understand this price mechanism (Nerlove and Bachman, 1960). Previous studies on supply response analysis had embraced different econometric models to examine the supply and production behavior of various agriculture commodities. Khan *et al.* (2003) used the Ordinary Least Square (OLS) and Maximum Likelihood Estimate (MLE) methodologies to examine the influence of Pakistan's support price policy program on wheat output from 1966 to 2001. Their statistical findings demonstrate that Pakistan's support price policy program has had a positive impact on wheat production levels. The farmers' yield, on the other hand, showed no influence

Adding Shahzad *et al.* (2018) analyzed the supply response of price and other non-price variables among the tobacco producers in Khyber Pakhtunkhwa (KP). Annual secondary data from the time span 1981 to 2014 was used in their analysis. Auto Regressive Distributed Lags (ARDL) was applied for the aim of estimation. The study results indicated that the short- and long-term projections of the tobacco elasticity of price and area were positive while wheat prices were negative. Waqas *et al.* (2019) investigated the supply response of un-irrigated wheat with data of KP for the time period 1981 to 2017. ARDL approach was used for analysis. Findings showed that other than price, un-irrigated wheat area, minimum temperature and rainfall had significantly positive impact on un-irrigated production of wheat whereas gram prices had significantly inverse relation with wheat production.

In the case of pulses crop, mixed literature is available on the nature of the acreage response to price and non-price elements. Some studies have found that the acreage response to change in pulses price is positive whereas some have noted an opposite phenomenon. Most researchers, however, believed that in explaining farmers' acreage response behavior, non-price elements are more essential than price elements. Grace K. *et al.* (2014) examined the association between productions of pulses, price or non-price

factors for example, rainfall, irrigated area and profit difference between cereals and pulses.

Keeping in view the few studies are available in context of Pakistan using ARDL model in mung bean pulses sector. The present research investigation is based on ARDL model to fill the research gap of empirical studies in mung bean pulses in Pakistan. The main objective of the research is to examine trends in supply of mung bean pulses in Punjab and to observe the role of different factors behind mung bean supply response for suggesting policy guideline in order to improve area and productivity of this crop.

DATA AND METHODS

The present study covers the major chunk of mung bean producing areas of Punjab. Initially data was collected for almost 32 districts of Punjab however; finally, those districts were selected for analysis that was producing 80 percent of mung bean pulses. The selected districts were Bhakkar, Khushab and MianWali. Annual provincial level data from 1980 to 2018 was gathered from different issues of Pakistan Economic Survey, Agricultural Statistics of Pakistan, Punjab Development Statistic, Crop Reporting Services Punjab etc. District wise time series data on all the relevant variables including area, production and yield of mung bean, as well as other competing crops (sugarcane and cotton) were collected. Data on input (DAP, Urea) and output prices of mung bean, other competing crops was also gathered. The co-integration analysis was done with the help of E-views software. The nominal values of input and output prices were transformed to real values using the GDP deflator. Natural logs of all of the variables were taken to deal with the data skewness and narrowing the variation among the time series data.

DATA ANALYSIS

Considering the existing literature on supply response in terms of research methodology, it is clear that prior studies were not based on modern time series analytical methodologies, and their results were considered unsatisfactory until and unless the stationarity issue was not taken into account in these studies. Those empirical studies were based on traditional (Nerlovian) econometric techniques like Nerlove's framework (1958), Askari and Cumming (1977), Savadatti, (2018), Riaz et al. (2014), Khan (2010), However, some studies (Abou-Talib et al 2008 and Alemu et al 2003) brought out several weaknesses of Nerlovian partial adjustment model. Firstly, this model fails to cope with short as well as long-term elasticities. Secondly, the non-stationary series analyzed under this model has more chances of spurious results of the regression. Due to these limitations, Nerlovian Partial Adjustment model is found less appropriate for supply response analysis, and Autoregressive Distributed Lag (ARDL) technique is given preference over Nerlovian Partial Adjustment for research methodology. Most of the studies recommended the Autoregressive Distributed Lag (ARDL) model when there is a mixed order of integration as ARDL can take enough numbers of lags to estimate the data generating process (Halam & Zanolli (1993), Akanni & Okeowo (2011) and Pesaran et al (2001). Furthermore, limited literature is available for mung bean pulse supply response in Pakistan.

An ARDL is a regression technique with both dependent and independent variable are in their lags form. The number of lags of the explanatory variable is denoted by ARDL (p,q).

$$\Delta Y_t = c_0 + \sum_{i=1}^p \gamma_{1i} \Delta Y_{t-i} + \sum_{i=0}^q \gamma_{2i} \Delta X_{t-j} + \pi_1 Y_{t-1} + \pi_2 X_{t-1} + \mu_t$$

Production of mung bean is assumed to be influenced by changes in its own price, as well as the pricing of competitor crops (cotton and sugarcane), as well as input prices (Urea and DAP).

$$\text{Mung bean Production} = f(\text{Mngprice}, \text{COTprice}, \text{UREAPrice}, \text{DAPprice}, \text{SCANPrice})$$

Equation statistically

$$\text{MNG prod}_t = \lambda_1 \text{MNGprice}_t + \lambda_2 \text{COTprice}_t + \lambda_3 \text{UREAPrice}_t + \lambda_4 \text{DAPprice}_t + \lambda_5 \text{SCANPrice}_t + \mu_t$$

Where:

MNGPrice = Ln of mung bean real price

COTPrice = Ln of cotton real price

UREAPrice = Ln of urea real price

DAPPrice = Ln of DAP real price

SCANPrice = Ln of sugarcane real price

ARDL Model for Mung bean:

$$\Delta \text{MNGPR}_t = \alpha + \lambda_1 \text{MNGP}_{t-1} + \lambda_2 \text{COTTP}_{t-1} + \lambda_3 \text{UREAP}_{t-1} + \lambda_4 \text{DAP}_{t-1} + \lambda_5 \text{SCANP}_{t-1} + \sum_{i=1}^q \pi_{1i} \Delta \text{MNGP}_{t-1} + \sum_{i=0}^q \pi_{2i} \Delta \text{COTTP}_{t-1} + \sum_{i=0}^q \pi_{3i} \Delta \text{UREAP}_{t-1} + \sum_{i=0}^q \pi_{4i} \Delta \text{DAP}_{t-1} + \sum_{i=0}^q \pi_{5i} \Delta \text{SCANP}_{t-1} + \epsilon_t, \quad i=1,2,3,\dots,n$$

Error Correction Model for Mung bean

$$\Delta \text{MNGPR}_t = c + \sum_{i=1}^p \beta_{1i} \Delta \text{MNGP}_{t-1} + \sum_{i=0}^q \gamma_{1i} \Delta \text{COTTP}_{t-1} + \sum_{i=0}^q \gamma_{2i} \Delta \text{UREAP}_{t-1} + \sum_{i=0}^q \gamma_{3i} \Delta \text{DAP}_{t-1} + \sum_{i=0}^q \gamma_{4i} \Delta \text{SCANP}_{t-1} + \theta \text{ECT}_{t-1} + \epsilon_t$$

RESULTS AND DISCUSSION

Stationarity test: A variety of tests for determining unit root are available, each with its own set of benefits, drawbacks, and applicability in particular situations. Although, pre-testing for stationarity is not required in this investigation while, using the ARDL technique. However; it is sufficient to ensure that not a single variable is I (2), as this technique requires. In the case of shorter data series, ADF and especially PP tests have the maximum power. Because the current study had a limited data set, ADF and PP tests were considered adequate.

The majority of the lag selection criteria were used to determine the lag numbers. The Schwartz Bayesian Criterion (SBC), Akaike Information Criterion (AIC) and Hannan Quinn Criterion (HQC), are the most often used criteria, however other software uses additional criteria as well (Shrestha *et al.*, 2018). All of the variables were stationary and were combined at the level and first difference. The findings of both tests were nearly identical (Table 1 and Table 2). The outcomes are consistent with previous findings (Mushtaq and Dawson, 2002; Mohammad *et al.*, 2007). Almost all of the variables are highly significant at the level, and the first differences demonstrate that none of the variables are I (2), which makes the ARDL approach viable for use.

Table:1. Augmented Dickey Fuller Test

	At Level		At first Difference		
	Constant	Constant & Trend	Constant	Constant & Trend	Decision
Variables	t-Statistics	t-Statistics	t-Statistics	t-Statistics	
Mung Prod	-4.12***	-3.83**	-	-	I (0)
Mung Price	-2.09	-2.03	-7.38***	-7.28***	I (1)

Cotton Price	-4.08***	-3.95**	-	-	I (0)
S-cane Price	-2.52	-2.40	-6.45***	-6.52***	I (1)
DAP Price	-1.93	2.46	-6.16***	-6.11***	I (1)
Urea Price	-1.93	-2.08	-5.74***	-5.66***	I (1)

Source: Author's calculations SIC criteria was used for lag length selection.

*, **, *** =significant @1,5 and 10% level respectively

Table:2. Philips-Perron (PP) Test

Variables	At Level		At First Difference		Decision
	Constant	Constant & Trend	Constant	Constant & Trend	
Mung Prod	-4.08***	-3.82**	-	-	I (0)
Mung Price	-2.92*	-2.93	-8.32***	-8.57**	I (1)
Cotton Price	-4.08***	-3.95**	-	-	I (0)
S-cane Price	-2.54	-2.43	-6.47***	-6.61***	I (1)
DAP Price	-1.89	-2.62	-6.16***	-6.11***	I (1)
Urea Price	-1.97	-2.17	-5.74***	-5.66***	I (1)

Source: Author's calculations SIC criteria was used for lag length selection.

*, **, *** =significant @1, 5 and 10 % level respectively

Bound Test: Mung bean production is assumed to be influenced by price fluctuations in its own crop, competitor crops and input prices. The Schwartz Information Criteria (SIC) was employed to pick lags because it produces relatively sparse lags, which is better suitable for smaller samples like the ones utilized in this study. The iteration method in Eviews software was used to evaluate a number of models before selecting the one with the best estimation.

Each of the variable has the following lags: lnMNGPR(1), lnMNGP(2), lnCOTP(2), lnSCP(2), lnUREAP (2) and lnDAP(1) The Bounds test was used to determine whether or not a long-term relationship existed. At 10.96, the F-statistic was high, rejecting the Ho of no long-run association at even a 1% level. For the small samples, Narayan (2005) determined bounds, which are presented in Table (3).

Table: 3 ARDL Bounds Test for Mung Model (1,2,2,2,2,1),

Test Statistic	Value	K
F-statistic	10.96*	6
Critical Value Bounds (Narayan) 2005		
Significance	I (0) Bound	I (1) Bound
10%	2.12	3.23
5%	2.45	3.61
1%	3.15	4.43

Source: Author's calculations

*, **, ***=significant @1, 5 and 10% level

To get insight into the supply response of mung, long-run coefficients were obtained for the five independent variables.

The long run coefficients result of ARDL indicated that mung bean production is not responsive to its own respective price as it is statistically insignificant as demonstrated in Table 4. The reason may be that the mung bean is relatively low priority catch crop grown as an intercrop between two major crops. The same result was observed in earlier studies Ali *et al*, 1998).

Sugarcane and cotton is the competing crop of mung bean. The ARDL results indicated a strong inverse relationship of sugarcane and cotton price with mung bean production with a high value of coefficient. This indicate that 1 percent rise in price of sugarcane will lead to 3.61 percent decline in mung bean production. Similarly, a one percent increase in cotton price will bring down the production of mung bean about 0.89 percent Same type of results were indicated by previous studies Ali *et al*, (1999). The major reason may be that sugar cane and cotton are the first-choice crop and with increase in sugarcane and cotton prices farmers switch to these crops by forgoing the production of mung bean. The above results supplement the facts that cereals are one of the major factors for declining and even stagnation of pulses production (Grace *et al*, 2014). Lack of enhanced technology and non-availability of quality seed the production of pulses does not rise considerably as compared to other cash crops like cotton and sugarcane (Narayan *et al*. 2015). As mung bean is a catch crop, risk and uncertainty involved in mung that's why farmers give priority to grow major crops on their lands (Ahmad *et al*. 1993).

Prices of major input like urea and DAP are statistically significant however they have an inverse relationship with mung bean production. The result reveals that a rise in urea prices by 1% will lead to decline in mung bean production by 0.68%. Similarly, a 1% increase in DAP fertilizer will bring a down the mung production by 0.38 percent. Table 5, highlighted the short run results of the model. The majority of the short run coefficients are statistically significant. The current period's estimated value of (ECT) was -0.56, implying that any disequilibrium will be addressed by 56 percent at current period.

Table: 4 Long-Run Coefficients for Mung Bean

Variable	Coefficient	Std. Error	t-Statistic	p-value
Mung Bean price	0.48	0.39	1.22	0.24
Cotton price	-0.89	0.32	-2.74	0.01*
Urea price	-0.68	0.61	-1.12	0.08***
DAP price	-0.38	0.34	-1.10	0.02*
S-cane price	-3.61	1.06	-3.38	0.00*
Constant	11.09	2.10	5.27	0.00

Source: Author's calculations

*, **, *** =significant at @5 and 10 % respectively

Table: 5 Short-Run Results for Mung Bean

Variable	Coefficient	Std. Error	t-Statistic	Probab.
d(lprice_mng)	-0.47	0.12	-3.82	0.002
d(lprice_mng(-1))	-0.60	0.15	-3.94	0.002
d(lprice_cot)	-0.22	0.13	-1.65	0.126
d(lprice_cot(-1))	0.39	0.12	3.24	0.007
d(lprice_urea)	0.56	0.34	1.63	0.130
d(lprice_urea(-1))	-0.77	0.27	2.78	0.017
d(lprice_dap)	-0.00	0.17	0.054	0.073
d(lprice_scan)	-0.45	0.22	-1.98	0.000

d(lprice_scan(-1))	1.12	0.22	4.93	0.137
ECT [-1]	-0.56	0.14	-3.92	0.002

Source: Author calculation Note: 'd' is difference operator.

Diagnostic Tests: The robustness of the derived regression model was assessed using a series of diagnostic tests. Coefficient diagnostics lag structure, and residual diagnostics are the most common diagnostic categories, with residual being the most essential. The frequently recognized residual diagnostics procedures of model specification test of omitted variable, autocorrelation, stability test, and normality test, that were utilized to discover the problem of heteroskedasticity (Shrestha and Bhatta 2018).

Table: 6 Diagnostic Tests

Test	Test Statistics	p-Value	Null hypothesis	Decision
Breusch-Godfrey LM test	5.17	0.75	No Serial Correlation	Accept Ho
Breusch-Pagan test	15.61	1.00	Constant Variance	Accept Ho
Ramsey RESET test	0.89	0.44	Model has no omitted variables	Accept Ho
Jarque-Bera test	0.24	0.88	Regression residuals are normally distributed	Accept Ho

Source: Author's calculations

For serial correlation, Mung bean was examined using the LM test. As the estimated p value is 0.75 that reveal that there is no serial correlation existed in the model and showing that the null hypothesis of no serial correlation is true. The computed P-value for the null hypothesis of homoskedastic variance is 1.0, the Breusch-Pagan test of heteroskedasticity confirmed that the data is homoskedastic the estimated P indicated to accept the null hypothesis of homoskedastic variance. Ramsey RESET test was used to verify model adequacy. The test's p result indicated that the model is well described. For checking normality of residual Jarque-Bera test was conducted estimated results revealed that the residuals are normally distributed (Table 6).

(CUSUM Squared) Test for Checking Stability

CUSUM tests were used to test the model's log-run stability. The model performed admirably in general and displayed reasonable long-term stability. For the CUSUM test, the lines kept within the 5% boundaries, indicating that the model is long-term stable.

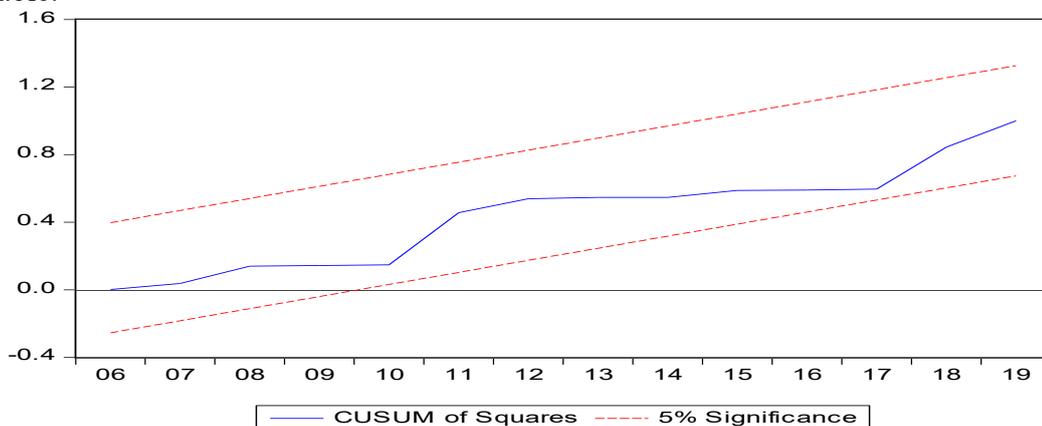


Fig. 1: CUSUM Test for Mung Model

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

In terms of production the mung bean has shown either stagnant or slightly positive and negative changes in production during the last one and half decade. The cultivated area under mung has an increasing trend over time while the trend in its production fluctuates wildly hinting at the yield variability. The susceptibility of mung bean low yield potential is due to traditional poor seed varieties, highest acceptability of disease, weather uncertainties and poor crop management practices, that affect the its production in Punjab, Pakistan.

Keeping in view the alarming situation of area and production, the current mung bean pulses production is difficult to fulfill the ever-increasing demand of fast-growing population of Pakistan. The purpose of this study was to look at the supply of this important pulse in Punjab-Pakistan, and determine the effect of various factors in the supply response mung bean.

The findings of this study revealed that both input-output prices factors had an impact on mung bean production. The findings demonstrated that mung bean producers are responsive to both input and output pricing, in contrast to several earlier studies from the 1960s that showed non-responsiveness. It is obvious from the data that farmers were price responsive and receive a greater price than competitive crops such as cereals. The inference might draw from the results that, despite high prices of mung bean farmers do not receive reasonable returns for their outputs as a result of reduced and also unstable mung bean yields, which are a result of the risk and uncertainty component involved in the production.

While on the other hand all major competing crops have statistically inverse relationship with this pulses production. Increase in prices of other competing crops lead to decline the production of mung bean. It can be explained that competing crops turned out to be more remunerative due to their high yield levels coupled with relative price increase. This acts as a disincentive for farmers taking up cultivation of pulses on increased area. In irrigated areas for the same reason whenever more irrigational facilities are available that induces farmers to allocate more land to other remunerative crops in place of pulses.

Recommendations

- In the short run a mung bean pulses package needs to be offered in the mung bean clusters, where a buy back guarantees and provision of improved seed at subsidized prices is ensured. The Punjab Government's subsidy package for Oilseed crops can be announced to increase mung bean area that further led to increase its production.
- Mung bean is a risky crop and grown on marginal areas and rain-fed conditions so its yield is relatively low and variable as compare to other competing crops. Hence, it is proposed to introduce some kind of insurance packages to farmers that motivate them to enhance the area under mung.
- To increase the mung-bean production keeping area same needs improvement in the production technology. For this purpose, in the long run, high yielding, and climate and disease resistant varieties of mung bean need to be developed while in the short run the recently released improved varieties need to be multiplied on war footings and made easily accessible to the farmers.

References

- Ali, M., & Abedullah, M. 1998. Supply, demand, and policy environment for pulses in Pakistan. *The Pakistan Development Review*, 35-52.
- Ali, M. 1988. Supply response of major crops in Pakistan: A simultaneous equation approach (No. 11). Directorate of Agricultural Policy and Chemonics International Consulting Division for the Economic Analysis Network Project in collaboration with the Ministry of Food, Agriculture, and Cooperatives, Government of Pakistan, and the United States Agency for International Development.
- A.K.Kannani and A.T.Okeowo. 2002. Analysis of aggregate output supply response of selected food grains in Nigeria. *J. of Stored Products and Postharvest Res.*, 2(14): 266 – 278.
- Anwar, F., Latif, S., Przybylski, R., Sultana, B., & Ashraf, M. (2007). Chemical composition and antioxidant activity of seeds of different cultivars of mungbean. *Journal of food science*, 72(7), S503-S510.
- Askari, H., and J. T. Cummings. 1977. *Agricultural supply response: A survey of the econometric evidence*. New York: Praeger.
- Abou-Talib, A. E. M., & MAMKH, B. 2008. Supply response for some crops in Egypt: A vector error correction approach. *J. Appl. Sci. Res.*, 4(12): 1647-1657.
- Alemu, Z. G., Oosthuizen, K., & Schalkwyk, H. V. 2003. Grain-supply response in Ethiopia: An error-correction approach. *Agrekon.*, 42(4): 389-404.
- Ahmed, B., Z. Hussain, & J. Longmire. 1993. *Farm management handbook, economics and policy analysis project* (Chemonics international consulting division), Agricultural Services Sector Project (ASSP) and United States Agency for International Development (USAID), Islamabad.
- Cai, R., McCurdy, A., & Baik, B. K. (2002). Textural property of 6 legume curds in relation to their protein constituents. *Journal of food science*, 67(5), 1725-1730.
- Chaudhry, M. I., Tajammal, M. A. and Hussain, A. (2002) "Pulse Varieties of Pakistan, Federal Seed Certification and Registration Department", Ministry of Food, Agriculture and Livestock: Islamabad; Pakistan.
- Dhindsa, K. S., & Sharma, A. (1997). A Regional Analysis of Growth and Supply Responses of Pulses-A Study of Punjab. *Indian Journal of Agricultural Economics*, 52(1), 87-100.
- Fouad, A. A., & Rehab, F. M. (2015). Effect of germination time on proximate analysis, bioactive compounds and antioxidant activity of lentil (*Lens culinaris Medik.*) sprouts. *Acta Scientiarum Polonorum Technologia Alimentaria*, 14(3), 233-246.
- Ghumman, A., Kaur, A., & Singh, N. (2016). Impact of germination on flour, protein and starch characteristics of lentil (*Lens culinari*) and horsegram (*Macrotyloma uniflorum L.*) lines. *LWT-Food Science and Technology*, 65, 137-144.
- Hall, C., Hillen, C., & Garden Robinson, J. (2016). Composition, nutritional value, and health benefits of pulses. *Cereal Chemistry*, 94(1), 11-31.
- FAO, (2016). FAOSTAT: Statistics for the year 2014. <https://faostat3.fao.org/home/E>.

- Grace K. T.K.Immanuelra and M.B.Dastagiri. 2014. Supply response with mix of stationary and non-stationary data: Case study in pulses, India. New Delhi Publishers.
- Hallam, D., and R. Zanoli. 1993. Error correction models and agricultural supply response. *Eur Rev Agric. Econ.*, 20(2):151-166
- Khan, R. A. and Hussain, S. M. A. 2007. Farm supply response to price: A case study of sugarcane in Pakistan (1986 – 2005). *J. Independent Stud & Res.*, (JISR) 5: (2)
- Khan, N. Z., Ahmad, M., & Rasheed, A. 2003. Wheat production in Pakistan: Saga of policy disincentives. *Pakistan Development Review*, 42(1): 1-27
- Khan, M. N. 2010. Production and acreage response of wheat in the North West Frontier Province (NWFP). *Sarhad J of Agric.*, 26(3): 427-433.
- Kumar S. and Bourai V.A. (2012) , ‘Economic Analysis of Pulses Production Their Benefits and Constraints’(A Case Study Of Sample Villages Of Assan Valley Of Uttarakhand, India)’ *IOSR Journal of Humanities and Social Science (IOSRJHSS) ISSN: 2279-0845 Volume 1, Issue 4 (Sep.-Oct. 2012)*, www.iosrjournals.org . pp (41-53).
- Mahmood, M. A., A. Sheikh, and M. Kashif. 2007. Acreage supply response of rice in Punjab. *J Agric. Res.*, 45(3):231-236.
- Mushtaq, K., & Dawson, P. J. 2003. Yield response in Pakistan agriculture: A cointegration approach (No. 1002-2016-78328).
- Narayan, P., & Kumar, S. (2015). Constraints of growth in area production and productivity of pulses in India: An analytical approach to major pulses. *Indian Journal of Agricultural Research*, 49(2), 114-124.
- Nerlove, M., and K. L. Bachman 1960. The Analysis of Changes in Agricultural Supply: Problems and Approaches. *J Farm Econ.*, 42: 531-554.
- Nerlove, M. 1958. The dynamics of supply; estimation of farmer's response to price (No. 04; HD1447, N4.).
- Pesaran, M. H., Shin, Y., & Smith, R. J. 2001. Bounds testing approaches to the analysis of level relationships. *J Appl. Econ.*, 16(3): 289-326.
- GoP. 2017. Pakistan Bureau of Statistics, Ministry of Planning, Development & Special Initiatives, Islamabad, Pakistan.
- Riaz, B., Ali, S., & Jan, D. 2014. Acreage Response Analysis of Maize Growers in Khyber Pakhtunkhwa, Pakistan. *Int. J Food and Agril Econ.*, 2(3): 33-44
- Shrestha, M. B. and G. R. Bhatta. 2018. Selecting appropriate methodological framework for time series data analysis. *The Journal of Finance and Data Scient*, 4: 71-89.
- Savadatti, P. 2018. Supply response analysis of pulses in India. *Int. J Res. Cult., Society.*, 2(1): 282-293.
- Shahzad, M., A.U. Jan, S. Ali and R. Ullah. (2018). Supply response analysis of tobacco growers in Khyber Pakhtunkhwa: An ARDL approach. *Field Crop Res.*, 218: 195-200.
- Shrestha, M. B. and G. R. Bhatta. 2018. Selecting appropriate methodological framework for time series data analysis. *J Finance & Data Scient.*, 4: 71-89.
- Waqas, M., Ali, S., Shah, S. A., & Ali, G. (2019). Supply Response of Unirrigated Wheat in Khyber Pakhtunkhwa, Pakistan: ARDL Approach. *Sarhad Journal of Agriculture*, 35(3), 902-912.