PRICE AND NON-PRICE FACTORS AFFECTING ACREAGE RESPONSE OF WHEAT IN DIFFERENT AGRO-ECOLOGICAL ZONES IN PUNJAB: A CO-INTEGRATION ANALYSIS

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The supply response has become more important and crucial research agenda associated with agricultural growth in Pakistan since the introduction of a series of policy reforms in agriculture sector. The extent to which farmers respond to economic incentives is, therefore central concern to policy makers. This underlines the importance of supply response analysis from time to time to assess the impact of incentives and adopted policies on agricultural production and to understand as to what possible adjustments can be made to improve or redesign policies in the changed scenario.

This paper estimates the supply response of wheat in all the agro-ecological zones in Punjab using the modern technique of cointegration. The recent research has shown that most time series data are often non stationary and its analysis through OLS leads to spurious results. Therefore, econometric technique of cointegration was used to avoid the problems. When combined with Error Correction Model (ECM), it offers a means of consistent estimates of both short- and long-run supply elasticties. Our unit root analysis suggests that underlying data series are most likely non-stationary. Subsequently, the presence of long-run relationship underlying the supply response model was examined. The Johansen multivariate cointegration approach indicates the presence of a cointegrating relationship in the supply response model. Inter-zonal comparison of supply response indicates different elasticities for each zone. Wheat acreage is significantly influenced by price of wheat, and other competing crops such as cotton and sugarcane. Among the non-price factors irrigation and rainfall has a positive effect on wheat acreage in the short-run. The wheat supply elasticities are found to be inelastic both in the short- and long-run. The long-run own-price acreage elasticities were 0.53, 0.46 and 0.49 in cotton, rice and mixed zones respectively.

Keywords: Supply response, wheat, cointegration, agro-ecological zones, Punjab.

INTRODUCTION

Wheat is the main Rabi crop grown in Pakistan and being the staple diet of people, occupies a central position in agricultural policies. It contributes 13.7 percent to the value added in agriculture and 3.0 percent to Gross Domestic Product (GOP, 2005-06). The food security of the country hinges upon the wheat productivity of the country. Punjab province is the major producer of wheat and contributes 76.7 and 78.8 percent to area and production of wheat respectively in the country. Wheat occupies 39.4 percent of total cropped area in Punjab. About 91 and 9 percent of the total wheat acreage is planted under irrigated and rain-fed conditions respectively. The area of wheat witnessed an increase from 2.90 to 6.48 million hectares during 1947-48 to 2005-06. The wheat production also increased from 2.64 to 16.77 million tones over the period (GOP, 2005-06).

There are four cropping zones in Punjab, which produce wheat. The shares of cotton, rice, mixed and barani zones to total wheat acreage in Punjab are 44.06, 26.78, 22.10 and 7.06 percent respectively. The corresponding contributions in wheat production are 44.42, 28.17, 23.04 and 4.07 percent, respectively (GOP, 2005-06).

Despite “Green Revolution” technologies and price incentives, the wheat supplies in the province are quite lower to the potential. The support price policy and technology no dought enhanced the wheat production but there is still a great potential in increasing wheat supplies horizontally as well as vertically in the province. This potential has to be realized to achieve wheat autarky in the country and to emerge as a net exporter of wheat.

This paper analyzes the price responsiveness of wheat farmers in different agro-ecological in Punjab. Employing the multivariate cointegration procedure developed by Johansen (1988), the long-run relationship between wheat acreage and price incentives was examined. The impact of certain non-price factors such as irrigation and rainfall on wheat acreage were also studied.

MATERIALS AND METHODS

Very little work has been conducted on agriculture supply response using cointegration analysis. The previous work of supply response was based on traditional methods. The seminal work of Krishna (1963), Falcon (1964), Cummings (1975) and

Tweenten (1986), Pinckey (1989), Khan and Iqbal (1991), Ashiq (1992) and Hussain and Sampath (1966c) no doubt provided policy insight to provide proper incentives to increase acreage and production of major crops, but the researchers applied usual statistical methods on time series data without any consideration to the presence of unit root. Recent research has proved that many time series are non-stationary and use of OLS on non-stationary data produce spurious regression (Johansen (1988) page 374). Most time series are trended over time and regression between such series may produce significant results with high R^2s, but may be spurious or meaningless (Granger and Newbold, 1974). Therefore, the previous studies on supply response in Pakistan might have produced results which are biased and unreliable. This study uses the most recent econometric technique of cointegration introduced by Granger (1981) and Engle and Granger (1987). This approach allows the investigator to specify an equation in which all terms are stationary, and so allow the use of classical statistical inference. It does not impose any restrictions on the short-run behavior of variables. It only requires an establishment of a stable long-run relationship, which formally implies that there exists a linear combination of variables that is stationary even though each single variable may be non-stationary. In this study, the techniques of cointegration have been used which avoids such biasedness. The techniques have been used by Mushtaq (2000) to estimate the response relationship though his study was based on aggregate data for Pakistan. This paper estimates the supply response at the disaggregate level.

The Data and the Model Specification

For our analysis Punjab has been divided into four different agro-ecological zones, cotton, rice, mixed and barani. The annual time series data pertaining to wheat area, real prices of wheat, cotton, refined sugar, rabi canal withdrawals and rainfall during the sowing season of crops for the period 1970-2001 were collected for all the zones through secondary sources (GOP, 1947 to 2006). All prices were deflated by whole sale price index to calculate real prices, which were used in the analysis. Rainfall variables in the area equations are those for sowing seasons of crops, when rainfall could affect sowing. Rabi canal withdrawals represent technology variables.

The specification of the wheat acreage response model for each zone differs owing to the growing of different competing crops. In cotton and mixed zones, wheat acreage is assumed to be a function of its own price (WPR), refined sugar price (RSPR), cotton price (CPR), Rabi canal water availability (RBWA) and rainfall during the sowing season (RFWA).The estimating equation was:

$$LWA = f_1 (LWPR, LCPR, LRSPR, LRBWA, LRFWA) \quad (1)$$

In rice zone wheat acreage is a function of its own-price (WPR), refined sugar price (RSPR), Rabi canal water availability (RBWA) and rainfall during the sowing season of crop (RFWA). The estimated equation was:

$$LWA = f_1 (LWPR, LRSPR, LRBWA, LRFWA) \quad (2)$$

One of our hypotheses was that the wheat acreage and output prices were jointly determined in each model. The exogenous variables such as rainfall and canal water availability during the sowing season of crop were also specified in the model.

The Johansen maximum likelihood approach for multivariate cointegration is based on the following VAR model:

$$Z_t = A_t Z_{t-1} + \dots + A_k Z_{t-k} + u_t \quad (3)$$

where Z_t = (n ×1) vector of $I(1)$ variable (containing both endogenous and exogenous variables), A_t is an (n ×1) matrices of parameters, and μ_t is an (n ×1) vector of white noise errors. Equation 3 can be estimated by OLS because each variable in Z_t regressed on the lagged values of its own and other variables in the model.

As Z_t is assumed to be non-stationary, therefore, to estimate the hypotheses of integration and cointegration in equation (3) we changed it into first-difference or vector error correction form.

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + A_2 \Delta Z_{t-2} + \dots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Gamma \pi Z_{t-k} + \mu_t \quad (4)$$

where $\Gamma_1 = I - A_1 - A_2, \dots - Ai$, (i = 1, …, k-1), and $\pi = -(I - A_1 - A_{2, \dots,} - A_{k})$

This specification provides information regarding short- and long-run adjustments to changes in Zt through the estimates of Γ_i and π respectively. The term πZ_{t-k} gives information about the long-run equilibrium relationship between the variables in Zt. The information about the number of cointegrating relationship between the variables in Zt is given by the rank of the matrix π. If the rank of π matrix r is $0 < r < .n$, there are r linear combination of variables in Z_t that are stationary. Here the π matrix can be decomposed into two matrices α and β such that π = α β, where α is error correction term, which measures the speed of adjustment in ΔZ_t, while β contains r distinct cointegrating vectors, showing cointegrating relationship between the non-stationary variables. Johansen procedure provides two likelihood ratio tests, the trace test and the maximum eigenvalue test. The trace test tests the null hypothesis of r cointegrating relations against the alternative of greater than r cointegrating relations, where r is the number of endogenous variables. The maximum eigenvalue tests the null hypothesis of r cointegrating vectors against the alternative of r+1 cointegrating vectors.

The estimation Method

In the empirical analysis, we begin by testing unit root to identify the order of integration of each single time series. We perform an augmented Dickey - Fuller (ADF) unit root test (Dickey and Fuller, 1981, and Said and Dickey, 1984), both with or without deterministic trend using Microfit 4.0. The annual time series data relating to wheat acreage, prices of wheat, cotton, sugarcane, Rabi canal withdrawal, rainfall during the sowing season is tested for unit roots for the period 1970 to 2001.

After establishing the order of integration of time series data, to use cointegration, we applied Johansen's approach (1988) which provides likelihood ratio tests for the presence of number of cointegrating vectors among the series and produces long-run elasticities.

Empirical Results

Tests for order of integration

Unit root analysis of all the series (in logarithms) with and without a linear trend is given in table 1. The results indicate that we cannot reject the null hypothesis of a unit root at 5 per cent level in all series except for all the rainfall series and rabi water availability (RFWA, RBWA), which appear to be *I* (0). These tests indicate that many series have a unit root interpret the long run relationships between I (1) variables. Some time series such as rabi canal water availability (RBWA) and rain fall in all the zones were found to be I (0)

Testing for cointegration

In the VECM modeling procedure, the first step in Johansen procedure was to define an unrestricted vector autoregression (VAR) using the equation (3). We carried out adjusted L-R tests with a maximum of four lags. The results for the wheat acreage model for cotton, rice and mixed zones given in Table 2 – 4 show that the L-R test statistics rejects order zero, but do not reject the VAR with order one. So we select one as the order of VAR for wheat acreage models for all the zones.

The second step in the Johansen method is the testing for the presence of number of cointegrating vectors among the series in the model. The cointegration results for the wheat acreage model for cotton, rice and mixed zones have been presented in table 5 – 7. The results for cotton zone given in table 5 implied that the trace test selects one cointegrating vector while maximal eigenvalue test selects two cointegrating vectors. Since trace test is the most powerful test, so our model implied one cointegrating vector. For rice and mixed zones both the trace and maximal eigenvalue tests select one cointegrating vector.

The Johansen model is a form of error correction model (ECM) and, where only one cointegrating vector exists, its parameters could be interpreted as estimates

Table 1. Results of Unit Root Tests Using ADF–Test in Different Zones, Punjab

Variables	Cotton Zone		Rice Zone		Mixed Zone	
	Unit Root[b]	Unit Root[c]	Unit Root[b]	Unit Root[c]	Unit Root[b]	Unit Root[c]
LnWA	- 1.194	- 2.149	- 1.374	- 1.711	- 1.46	- 1.61
LnWPR	- 2.93	- 3.025	- 2.644	- 3.051	- 2.25	- 2.39
LnCPR	- 2.333	- 2.361	-	-	- 1.18	- 2.25
LnRSPR	- 1.774	- 2.688	- 1.668	- 2.032	- 1.46	- 2.84
LnRFWA	- 5.205*	- 5.105*	- 5.098*	- 4.955*	- 6.04*	- 4.65*
LnRBWA	- 3.448*	- 3.724*	- 5.152*	- 5.052*	- 5.93*	- 6.83*
5% Critical values	- 2.970	- 3.579	- 2.970	- 3.579	- 2.970	- 3.579

Note: - * indicate absence of unit root'. **"b"** values indicate unit root values with an intercept and no trend; **"c "** values indicate unit root with an intercept and linear trend. The lag length of ADF assumed to be three is chosen so as to minimize the Akaik and Schwarz Information Criterion

in their level form.

The analysis indicated that in irrigated zones, wheat acreage, prices of wheat, cotton, and refined sugar have a unit root in their level form. Being *I*(1), these variables were subjected to cointegration analysis. However, wheat acreage in barani zone turned out to be stationary i.e., I (0). These I (0) series cannot of long-run cointegrating relationship between the variables (Hallam and Zanoil, 1993). Therefore, the estimated parameter values from these equations when normalized on acreage are long-run elasticities. These coefficients show estimates of long-run elasticities of wheat acreage with respect to wheat, cotton and refined sugar prices given in Table 8.

Table 2. Selecting order of VAR for wheat acreage model, cotton zone

List of variables included in the unrestricted VAR:
LWA LWPR LCPR LRSPR
List of deterministic and/or exogenous variables
CONSTANT LRBWA LRFWA

Order	AIC	SBC	Adjusted LR test
4	114.5839	44.6432	-------
3	92.0482	38.7600	23.7679 [.533]
2	78.0592	41.4236	43.2623 [.739]
1	82.9907	63.0076	53.2966 [.973]
0	45.2639	38.5944	124.9239 [.046]

Note: p – values in the parentheses.

Table 3. Selecting order of the VAR for wheat acreage model in rice zone

List of variables included in the unrestricted VAR:
LWA LWPR LRSPR
List of deterministic and/or exogenous variables:
CONSTANT LRBWA LRFWA

Order	AIC	SBC	Adjusted LR test
4	107.2651	79.2888	-----
3	101.7898	79.8084	14.4753 [.106]
2	90.3587	74.3722	34.9064 [.010]
1	94.0305	84.0390	40.2345 [.049]
0	38.7547	27.7513	167.0198 [.000]

Note: p – values in the parentheses.

Table 4. Selecting order of the VAR for wheat acreage model, mixed zone

List of variables included in the unrestricted VAR:
LWA LWPR LCPR LRSPR
List of deterministic and/or exogenous variables
CONSTANT LRBWA LRFWA

Order	AIC	SBC	Adjusted LR test
4	124.9873	55.0466	--------
3	106.4654	53.1772	21.7610 {.650}
2	91.2472	54.6116	41.8700 {.786}
1	100.6362	80.6531	49.6756 {.989}
0	69.8614	63.1919	142.4244 {.003}

Note: p – values in the parentheses.

Estimation of error correction model

Finally we estimate the ECMs for each cointegrating vector for which general-to-specific modeling procedure of Hendry and Ericsson (1991) was applied in selecting the preferred ECM. This method first estimates the ECM with different lag lengths for the difference terms and, then, simplifies the representation by eliminating the lags with insignificant parameters.

The ECMS in general for wheat acreage model has been explained in equation 5. However, the equation is different for each zone depending upon cointegrating relationships given in tables 5 – 7

$$\Delta WA_t=\delta_0+\sum_{i=1}^{4}\delta_{1i}\Delta WA_{t-i}+\sum_{i=1}^{4}\delta_{2i}\Delta WPR_{t-i}+\sum_{i=1}^{4}\delta_{3i}\Delta RSPR_{t-i}+\sum_{i=1}^{4}\delta_{4}\Delta CPR_{t-I}$$

$$+\delta_5 RBWA+\delta_6 RFWA-\alpha EC_{t-1} \quad (5)$$

Where $\alpha EC_{t-1}=\alpha(WA_{t-I}-\beta_1 WPR_{t-1}-\beta_2 RSPR_{t-1}-\beta_3 CPR_{t-I})$

Where $\alpha EC_{t-1}=\alpha(WA_{t-I}-\beta_1 WPR_{t-1}-\beta_2 RSPR_{t-1}-\beta_3 CP$

In the above error correction model, the difference terms on the right hand are lagged a number of times depending upon the significance of the t-test; δs explains the short-run effect of changes in the explanatory variables on the dependent variable; β's represent the long-run equilibrium effects. αEC_{t-1} are the error correction terms and corresponds to the residuals of the long-run cointegration relationship. The negative sign on the error correction term indicates that adjustments are made towards restoring long-run equilibrium. Short-run adjustments are therefore guided by, and are consistent with the long-run equilibrium relationship. This method provides estimates for the short-run elasticities (i.e., coefficients of the difference terms), whereas the parameters from the Johansen cointegrating regression (Table 8) are estimates of the long-run elasticities (Townsend and Thirtle, 1994).

The error correction model estimates for wheat acreage of cotton, rice and mixed zones shown in tables 9-11 revealed that wheat acreage in all the zones is dependent upon prices of wheat and competing crops in respective zone i.e., cotton, sugarcane, water availability and rainfall during the sowing period of wheat crop. An increase in wheat price positively affected the wheat acreage in all the zones but differently; a one percent increase in wheat price increased the wheat acreage in cotton, rice and mixed zones by 0.12, 0.08 and 0.09 in the short-run, and 0.53, 0.46 and 0.49 in the long-run respectively. Cotton price has both positive and negative effect on wheat acreage in the short-run and insignificant negative effect in the long-run in cotton and mixed zones. Our two- third of wheat area comes after cotton. A high cotton price provides incentive for farmers to keep cotton crop standing in the field for a longer period in order to pick even the last boll. This affects the wheat supplies in the sense that less time is left to prepare land for wheat sowing and some area remains fallow and shifted to other crops. Sugarcane price negatively affected the wheat acreage in all the zones; a one percent increase in the price of refined sugar

Table 5. Johansen cointegration results for wheat acreage model, cotton zone

Relationship	Hypotheses		Maximal Eigenvalue test	Trace test
	Ho: r	H_A: (n-r)		
LWA, LWPR, LCPR, LRSPR, LRBWA, LRFWA	0	5	49.04 (34.40)	99.51 (75.98)
	1	4	32.98 (28.27)	50.47 (54.11)*
	2	3	8.27 (22.04)*	17.49 (34.87)
	3	2	5.18 (15.87)	9.21 (20.18)
	4	1	4.03 (9.16)	4.03 (9.16)

Notes: (1) Critical values in the parentheses;
(2) *indicates where the null is not rejected for the first time moving through the table row by row from left to right.

Table 6. Johansen cointegration results for wheat acreage model, rice zone.

Relationship	Hypotheses		Maximal Eigenvalue test	Trace test
	Ho: r	H1: (n-r)		
LWA, LWPR, LRSPR, LRBWA, LRFWA	0	3	32.15 (22.04)	55.36 (34.87)
	1	2	13.23 (15.87)*	15.20 (20.18)*
	2	1	0.07 (9.16)	0.07 (9.16)

Notes: as for Table 5.

Table 7. Johansen cointegration results for wheat acreage model, mixed zone

Relationship	Hypotheses		Maximal Eigenvalue test	Trace test
	Ho: r	H1: (n-r)		
LWA, LWPR, LCPR, LRSPR, LRBWA, LRFWA	0	5	35.22 (34.40)	91.56 (75.98)
	1	4	20.49 (28.27)*	41.34 (53.48)*
	2	3	9.30 (22.04)	20.85 (34.87)
	3	2	6.73 (15.87)	11.54 (20.18)
	4	1	4.81 (9.16)	4.81 (9.16)

Notes: as for Table 5.

decreased the wheat acreage by 0.29, 0.37 and 0.48 percent in the long-run in cotton, rice and mixed zones respectively. Irrigation and rainfall during the sowing season of wheat turned out to be important non-price variables explaining the wheat acreage in the short-run. A one percent increase in the rabi canal withdrawal increased the wheat acreage by 0.416, 0.364 and 0.325 percent in the respective zones. Similarly, a one percent increase in the quantity of rainfall increased the wheat acreage by 0.027, 0.045 and 0.036 percent respectively

Table 8. Johansen normalized estimates for the wheat acreage model

Wheat Acreage Equation for Cotton Zone
WA = 0.531 WPR – 0.023 CPR - 0.294 RSPR + 5.428
Wheat Acreage Equation for Rice Zone
WA =0.463WPR – 0.374 RSPR + 2.974
Wheat acreage Equation for Mixed Zone
WA = 0.492 WPR – 0.018CPR + 0.483 RSPR + 6.352

An inter-zonal comparison of elasticities for wheat and comparison of elasticities from this study with those from previous studies in Pakistan are reported in Table 12. Our study show almost higher supply elasticities than nearly all the studies reviewed except Ashiq (1991). This may be due to difference in data, the period of study, model specification, and estimation techniques used. Further, inter-zonal comparison of elasticities showed that long-run supply elasticities for wheat are higher for cotton zone, followed by mixed zone and rice zone. In barani zone, wheat acreage model is not estimated as wheat acreage series is I (0). The long-run elasticities are greater than those in the corresponding short-run as expected in almost all zones. This implies that rigidities influencing wheat farmer's decisions are less restrictive in the long-run. The short-run and long-run own-price acreage and yield elasticities are inelastic. Our analysis suggests that farmers in all zones respond to incentives.

Table 9. ECM estimates for the wheat acreage model, cotton zone.

Regressors	Short-Run	Long-Run
Constant	-	5.428 (2.75)*
Δ WPR_t	0.125 (2.68)*	0.531(3.95)*
Δ CPR_t	0.086(2.50)*	- 0.023(- 0.16)^{NS}
Δ CPR_{t-1}	- 0.043(-2.47)*	-
Δ CPR_{t-2}	- 0.057(-1.76)*	-
Δ $RSPR_{t-2}$	-0.021(-1.75)**	- 0.294(- 5.28)*
RBWA	0.416 (5.25)*	
RFWA	0.027 (2.61)*	
EC_{t-1}	- 0.242 (- 4.75)*	
R^2	0.79	
LM-$ℵ^2$ (1)	3.12	
LM-$ℵ^2$ (2	3.23	
LM-$ℵ^2$ (3)	4.75	
LM-$ℵ^2$ (4)	5.10	
RESET-$ℵ^2$ (1)	0.17	
Jarque-Bera Normality-$ℵ^2$ (2)	0.95	

(1) t - ratios in the parentheses
(2) (*) (**) indicates significance at the 5 and 10 percent levels
(3) NS = Not Significant

Table 10. ECM estimates for the wheat acreage model, rice zone

Regressors	Short-Run	Long-Run
Constant	-	2.974(3.56)*
Δ WPR_t	0.082(2.45)*	0.463(2.32)*
Δ $RSPR_t$	-0.025(1.98)*	- 0.374(-4.52)*
RBWA	0.364 (1.59)*	
RFWA	0.045(2.15)*	
EC_{t-1}	-0.153(- 2.67)*	
R^2	0.88	
LM-$ℵ^2$ (1)	1.29	
LM-$ℵ^2$ (2	5.10	
LM-$ℵ^2$ (3)	5.13	
LM-$ℵ^2$ (4)	5.39	
RESET-$ℵ^2$ (1)	0.398	
Jarque-Bera Normality-$ℵ^2$ (2)	0.443	

Notes: as for table 9.

Conclusions and policy implications

Using Johansen's Cointegration approach, this paper estimates the long-run relationship between wheat acreage, price incentives and non-price factors in different agro-ecological zones in Punjab. Two basic results turned out from the analysis. First, the estimated supply elasticities came out to be less than one, but they appeared to be high enough to imply that further agricultural reforms are required. Second, irrigation and rainfall appeared to be important non-price variables explaining wheat acreage.

Our result indicate that cotton and sugarcane crops compete with wheat crop in cotton and mixed zones, while in the rice zone sugarcane competes with wheat. Since our two-third wheat acreage follows cotton crop, therefore, early maturing and short duration cotton varieties should be evolved to clear area timely for wheat sowing. The maximum area of ratoon sugarcane crop could be brought by adjusting the crushing season of sugarcane by the sugar mills and checking the exploitation of farmers in the disposal of sugarcane during the sowing season of wheat. Further, Sugarcane crop is a high water intensive crop and in view of water scarcity in the province, its area should be restricted to a desirable level and productivity should be increased. This will spare some area and water for increasing wheat and cotton acreage in the province. An adequate policy intervention is therefore, essential in allocation of sugarcane specific areas on the basis of water availability and comparative advantage. Water is the critical input and limiting factor in production. The government must address water security issue by introducing better water management practices and developing political consensus to build more reservoirs. Institutional reforms should be the main focus of development in irrigation in the future. Increasing efficiency of the irrigation system will require substantive improvement in water management as well as increased water supply and will demand better financial, managerial and technical planning.

Table 11. ECM estimates for the wheat acreage model, mixed zone

Regressors	Short-Run	Long-Run
Constant	-	6.352(1.52)*
Δ WPR_t	0.085(2.18)*	0.492(3.27)*
Δ CPR_t	0.078(-1.92)*	-0.018(-0.24)^{NS}
Δ CPR_{t-1}	-0.035(-2.17)*	-
Δ CPR_{t-2}	-0.069(-2.52)*	-
Δ $RSPR_{t-2}$	-0.034(-2.15)*	-0.483(-4.68)*
RBWA	0.325 (4. 70)*	
RFWA	0.036 (5.17)*	
EC_{t-1}	-0.257(-2.75)*	
R^2	0.47	
LM-$ℵ^2$ (1)	1.26	
LM-$ℵ^2$ (2	3.52	
LM-$ℵ^2$ (3)	5.43	
LM-$ℵ^2$ (4)	5.62	
RESET-$ℵ^2$ (1)	2.48	
Jarque-Bera Normality-$ℵ^2$ (2)	3.47	

Notes: as for table 9.

Table 12. Comparison of own-price acreage elasticities for wheat in Pakistan

Source	Period	Acreage	
		SR	LR
Krishna (1963)	1913-46	0.08	0.14
Falcon (1964)	1933-59	0.10 - 0.20	-
Cummings (1975)	1949-68	0.10-0.22	-
Ashiq (1981)	1957-80	0.25	12.50
Tweeten (1986)	1962-83	0.07	0.27
Pinckey (1989)	1967-87	0.09	0.20
Khan & Iqbal (1991)	1956-87	0.07	0.11
Hussain & Sampath (1966c)	1970-93	0.06	0.21
Mushtaq (2000)	1960-96	0.08	0.45
This Study Cotton Zone	1970-2001	0.12	0.53
Rice Zone	1970-2001	0.08	0.46
Mixed Zone	1970-2001	0.09	0.49

Our results revealed that Farmers in different agro-ecological zones in Punjab are responsive to appropriate incentives. However, the degree of responsiveness for each zone depended upon the position of the crop in each zone, the degree of specialization of crop, its degree of commercialization, the availability of resources, socio-economic conditions of farmers and infrastructural development. Further, our study showed higher supply elasticities than previous studies conducted in Pakistan. This may be due to difference in data, the period of study and estimation technique used.

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