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ACREAGE RESPONSE OF MAJOR CROPS IN PAKISTAN (1970-71 to 2006-07)

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ABSTRACT

This study using the Nerlovian model has estimated the responses of cotton, wheat and sugarcane crops' area to changes in their prices and other relevant factors in Pakistan. Time period covered in the analysis relates from 1970-71 to 2006-07. The coefficients of the area response models for respective crops were estimated through the Ordinary Least Squares method. The short run price elasticity of cotton area has been estimated at 0.263 while the long run price elasticity works out to 1.09. The short run price elasticity of wheat area during the study period has been calculated at 0.045 while the long run price elasticity comes to 0.105. The short run price elasticity of sugarcane has been calculated at 0.229 while long run elasticity comes to 0.653. The conclusion of all this discussion is that there are powerful monopolies or oligopolistic structures in cotton, wheat, and sugarcane markets which distort the incentives for the producers resulting in wasteful and inefficient use of national resources. There is need to remove these distortions and correct market imperfections so as to make best use of the available resources and increase farm production and improve our competitiveness in world markets.

Keywords: model, cotton, wheat, sugarcane, area response, price elasticity.

1. INTRODUCTION

Agriculture which in most of the developing countries is the largest commodity producing sector: in terms of its contribution to GDP, employment of labor force and providing means of livelihood to a large section of the population holds the key for the development of the economy and success of the efforts aimed at poverty alleviation.

In the context of modernizing traditional agriculture T.W. Schultz (1964) argued that lack of knowledge with respect to the contribution of agriculture to growth has bred many a doctrine and political dogmas. One of such doctrines was that farmers are not responsive to economic incentives. An important dimension of the question in this context was could agricultural production in low income communities be substantially increased by an efficient allocation of the factors of production at their disposal? How much additional agricultural production can be achieved by improving allocative efficiency of farming?

The role of incentives which has become to be taken for granted for the success of any agricultural development program today was not always like so. A number of empirical studies in the 1960s (Raj Krishna 1963, Falcon 1964, Mubyarto 1965, Behrman 1968, and Yotopoulos 1964, 1968,) addressed the question of farmers' response to economic incentives and efficient allocation of resources through the analysis of both time series and cross sectional data from a number of developing countries.

Agriculture sector in Pakistan during the last three decades or so has witnessed a number of developments both in the factor and product markets and experienced many policy shifts resulting in substantial changes in the structure of market incentives faced by farmers. However, quite a few of these changes have been crop specific/ crop oriented, as there have been wide variations in quantum of changes in the incentives.

The performance of various crops over time also reflects wide variation perhaps in response to varying incentives. This study following the supply response framework of analysis is intended to examine the performance of three of the most important crops: cotton, wheat and sugarcane of Pakistan in terms of their area/production and the role played by market incentives in this regard.

The performance of these crops has important bearing not only for the growth and development of agriculture but also the capacity utilization and growth of the industrial sector which depends for the supply of its raw material on agriculture. The textile sector, home to the largest industry in the country, comprising 458 textile mills, 77 thousands rotors, 8.8 million spindles and 1221 ginning factories has crucially depended on cotton farming in the country for the supply of its raw material.

The cotton seed, a valuable by product of cotton farming, has helped in the supply of raw material for the domestic vegetable ghee industry and also provided protein rich feed for dairy and livestocks. Wheat is the staple food crop and has been often in the news for its shortages and rising flour prices. It is also the source of raw material for the flour mills supplying flour to the urban population. The sugar industry comprising around 80 sugar mills of varying capacity, with overall capacity of manufacturing 7.1 million tons of refined sugar annually, the second largest industry of the country depend on sugarcane farming. The industry has been in the news during the last few years sometimes for inadequate supply of raw material and sometimes or opposite reasons. From the foregoing it is apparent that there are many forward

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linkages of these crops with the industry and other sectors of the economy, which generate employment and value addition in the economy.

There is a large empirical literature on agricultural supply response. Some of these include Krishna (1963), Cummings (1975), Askari and Cummings (1977), Tweeten (1986), Ali (1987), Pinckney (1989), Khan and Iqbal (1991), Hennebery and Tweeten (1991). Ashiq (1992), Himayatullah (1994), Hussain and Sampath (1996) and Khalid (2002).

The objective of this study was to increase our understanding of the specification and estimation of agricultural acreage response as well as to provide instruments for agricultural policy analysis.
Main objectives of the study were as follows:

- To quantify acreage responses of cotton, wheat and sugarcane for 1970-71 to 2006-07;
- To work with relatively more dynamic approach to address the issues;
- To estimate and compare short and long run elasticities; and
- To understand factors affecting crop supply response.

The structure of the paper is as follows: Section 2 discusses model specification and data, Section 3 discusses our methodology, Section 4 discusses the analysis and results and Section 5 concludes and presents policy implications.

2. MODEL SPECIFICATION AND DATA

This section discusses the nature, sources, and limitations of the data and specification issues. The empirical analysis of this study will be conducted with a sample of annual data that cover Pakistan's major crops: wheat, cotton and sugarcane for the time period 1970-71 to 2006-07.

Wheat and cotton are both complementary and competing crops: complementary in the sense that they can both be raised on the same land in sequence/rotation in a given year; and competing in a way that substantial proportion of wheat planting takes place after cotton harvest and high cotton price provides an incentive to farmers to keep cotton in the fields for longer duration than usual so as to increase the number of pickings. This leaves less time for land preparation and wheat sowing. Resultantly, in years of good cotton prices wheat area may contract.

Sugarcane is an annual crop. It may occupy the land for 12/18-months and may be ratooned subsequently for 2 to 3 crops depending upon agro-climatic conditions and economic environment. Thus area planted to sugarcane may not become available for growing other crops in the next 2-3 years.

In addition to the economic factors as manifested by the prices of a given commodity/crop a number of other factors like the availability of water and other inputs, development of infrastructure, institutional support, economics of competing crops, etc impact on farmers allocation of resources to a given crop.

In the estimated models crop area has been used as a dependent variable. The crop area has been preferred over the production as farm production is also influenced by weather conditions, which are beyond the control of farmers. Yield is subject to more random variation than acreage due to factors outside the farmers' control such as the weather.

Based on our extensive review of literature, discussions with experts and knowledgeable farmers we have identified the following factors impacting on farmer's allocation of crop area.

Acreage = f (real price of output at time t-1, yield of output at time t-1, area planted to output at time t-1)

Prices of a commodity received by the farmers in the recent past in lieu of the expected price at harvest time which is not known at the planting time, yield of the given crop obtained in last year as it inter alia shapes economic incentives for the commodity, yield of competing crops as a proxy for the opportunity cost and farmers' know how and experience about the cultivation of the crop.

At the sowing time farmers are not sure of the prices to be available at the harvest time in spite of the announcement of support prices, designed to provide a floor to the market price because of inadequate institutional arrangement for implementation. A perusal of the historical prices data has indicated a considerable variation between the market and support prices of various crops in general and seed cotton in particular. Accordingly, the prices received by the growers in the last season are used as an independent variable. However, the real prices i.e. market prices deflated by the GDP deflator in lieu of the nominal prices were used to offset the likely impact of inflation in this context.

Yield is an important determinant of the profitability of the crops in a given year. However, as the yield of any crop at its planting time is unknown, farmers' base their expectation of profitability of a given crop on the yield realized in the recent past. In case of cotton we have data on lint yield but not of seed cotton from published source. We have adopted it as an independent factor, as multiplying or dividing it with some factor to obtain data of seed cotton would be immaterial. Lagged area is also used as an independent variable in the hope that it captures the effects of farmers knows how and experience with the given crop.
Cotton acreage is specified as:

Cotton acreage = f (real price of cotton at time t-1, yield of cotton at time t-1, yield of sugarcane at time t-1, yield of rice at time t-1,area planted to cotton at time t-1)

Cotton a summer crop in Pakistan faces competition from other kharif crops. Rice is also a summer crop. Rice and cotton because of their widely different requirements of factor inputs and agroclimatic conditions do not normally compete against each other except in certain areas. Sugarcane as an annual crop competes with cotton for area. The sowing period of the crop overlaps with cotton. So we use sugarcane yield as an independent variable.

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Wheat acreage is specified as:

Wheat acreage = f (real price of wheat at time t-1, yield of wheat at time t-1, real price of cotton at time t, area planted to wheat at time t-1)

Sugarcane acreage is specified as:

Sugarcane acreage = f (real price of sugarcane at time t-1, yield of sugarcane at time t-1, area planted to sugarcane at time t-1)

Sugarcane is an annual crop. Area planted to sugarcane may not become available for sowing other crops for 2-3 years due to rationing. However, because of its longer duration and high water requirements its cultivation is confined to certain well defined regions.

As farmers fail to exploit the current information fully or such information is lacking or cost-prohibitive, then a lagged price response model may be reasonable. Lagged real prices (nominal prices deflated by the GDP deflator in 1995-96, Rs. /40 kg) are used.

The data on area and yield of various crops were obtained from various issues of Agricultural Statistics of Pakistan. Data on harvest price of various crops were obtained from the following sources (Table-1).

Table-1. Sources of price data.

Price	Source
Seed cotton	Pakistan Central Cotton Committee
Wheat	Federal Bureau of Statistics
Sugarcane	Federal Bureau of Statistics
Rice yield	Agricultural Prices Commission

GDP deflator as a measure of inflation in the economy is estimated and given in the International Financial Statistics and was adopted as such from there.

3. THE METHODOLOGY

To empirically estimate how the quantity supplied responds to changes in its prices and other relevant variables, discussed earlier, we need to move from an economic model to a statistical model that we can estimate. With all variables in logarithmic terms for convenience of mathematical manipulations and for direct estimation of elasticities, the proposed model is explained as follows:

Nerlove's model describes the dynamics of agricultural supply by incorporating price expectations and/or adjustment costs. In a linear form this relationship is expressed as

$$Q_t = \alpha + \beta P^*_t + \gamma Z_t + U_t \qquad (1)$$

Where Z_t denotes other exogenous factors and U_t is a disturbance term. Since expected price is unobservable, the expectations are assumed to be formed as

$$P^*_t = P_{t-1} + \delta (P_{t-1} - P^*_{t-1}) \qquad 0< \delta \leq 1 \qquad (2)$$

Where Pt denotes actual price in period t and δ is the coefficient of expectation.

If δ approaches 0, there is no difference between this year's expected price and last year actual price, and if δ = 1, expected price is identical to last year actual price. Equation (2) implies that farmers adapt their expectations of future price in the light of past experience and that they learned from their mistakes. By rearranging (2) it can be easily show that current year expected price is a proportion of both last years' actual and expected prices. Thus price expectations are weighted moving average of past prices in which the weights decline geometrically. Substituting (2) into (1) and rearranging gives,

$$Q_t = \delta\alpha + \delta\beta P_{t-1} + \delta\gamma Z_{t-1} + (1-\delta) U_{t-1} + V_t \qquad (3)$$

Where $V_t = U_t - (1-\delta) U_{t-1}$ which is the adaptive expectation model.

Now consider the partial adjustment (PA) model. Assume that desired area Q_t is a function of price (P_t) and other exogenous factors (Z_t).

$$Q^*_t = \alpha + \beta P_t + \gamma Z_t + U_t \qquad (4)$$

Since desired area is unobservable, the PA hypothesis is

$$Q_t - Q_{t-1} = \lambda (Q^*_t - Q_{t-1}) \quad 0< \lambda \leq 1 \qquad (5)$$

Where λ is the area adjustment coefficient and indicates the speed of adjustment between desired and actual area in the previous period. If λ approaches to 0, area remains unchanged from year to year, and if λ =1 adjustment is instantaneous. Typically, adjustment to the desired level is likely to be incomplete because of physical and institutional constraints, fixed capital, risk etc. Note also that λ provides the link between the short and long-run elasticities. The long-run price elasticity is equal to the short run elasticity divided by λ. Rearranging (5) and substituting into (4) gives the PA model:

$$Q_t = \lambda\alpha + \lambda\beta P_t + \lambda\gamma Z_{t-1} + (1-\lambda)Q_{t-1} + \lambda U_t \qquad (6)$$

Combining (1) and (4) gives

$$Q^*_t = \alpha + \beta P^*_t + \gamma Z_t + U_t \qquad (7)$$

Where both desired area level (Q^*_t) and expected price (P^*_t) are unobservable. Substitution of (2) and (5) in (7) gives the estimating equations.

$$Q_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 Q_{t-1} + \alpha_3 Q_{t-2} + \alpha_4 Z_t + \alpha_5 Z_{t-1} + V_T \qquad (8)$$

Where $\alpha_0 = \delta \lambda \alpha$, $\alpha_1 = \delta \lambda \beta$, $\alpha_2 = (1-\delta) + (1-\lambda)$,

$\alpha_3 = -(1-\delta)(1-\lambda)$, $\alpha_4 = \lambda\gamma$, $\alpha_5 = -\lambda \gamma (1-\delta)$,

and $V_t = \lambda U_{te} - \lambda (1-\delta) U_{t-1}$

4. ANALYSIS AND RESULTS

The results of the estimated cotton, wheat and sugarcane models and related statistics are presented and discussed in this section. The first stage in examination of these results is to look for their plausibility in terms of economic theory and logic, a priori expectations of signs

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of the estimated coefficients and their size. The estimated models are discussed one by one in the following paragraphs.

4.1 Empirical estimates of cotton area model

The coefficients of the estimated model along with the related statistics are presented in Table-2.

Table-2. Estimated coefficients of cotton response function (1970-71 to 2006-07).

Dependent variable = Ln (cotton area)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	5.223	3.954	1.320	0.196
Real price of cotton at time t-1	0.263	0.122	2.153	0.039
Yield of cotton at time t-1	0.275	0.124	2.218	0.034
Yield of sugarcane at time t-1	-0.617	0.372	-1.656	0.108
Yield of rice at time t-1	0.174	0.324	0.537	0.595
Area planted to cotton at time t-1	0.758	0.115	6.577	0.000
R-squared	0.852	Mean dependent var		8.627
Adjusted R-squared	0.827	S.D. dependent var		0.306
S.E. of regression	0.127	Akaike info criterion		-1.126
Sum of squared resid	0.471	Schwarz criterion		-0.860
Log likelihood	25.718	F-statistic		33.606
Durbin-Watson stat	1.987	Prob (F-statistic)		0.000

Note: All the variables are in logarithmic form.

All the tests for model adequacy yield satisfactory results. The R^2 is quite high and the estimated equation explains about 85 percent of the variation in the dependent variable. Similarly, F ration confirms overall fitness of the model. D-W statistics is also indicative of the lack of serial correlation in the residuals. However, to confirm this result we proceed to calculate Durbin (h) statistics because lagged dependent variable has been used as one of the independent variables. Estimate of Durbin (h) statistics does not suggest any evidence of serial correlation. The Reset test for functional form mis-specification was below the critical value, indicating acceptance of the hypothesis of a correct functional form. The Jarque-Bera test for normality in the residuals gave a result below the critical value, thus accepting the null hypothesis of normally distributed residuals, with no evidence of hetroscedasticity in the residuals.

Table-3. Diagnostic tests.

D.h Statistic	0.1
Jarque Bera	0.92 (0.63)
Reset Test	0.07 (0.78)

The coefficients, which in our case indicate the elasticities of cotton area with respect to the respective variables, in most of the cases have logical signs and are consistent with economic theory. The coefficients of various variables are explained:

Lagged real price

The coefficient of the real price (lagged) of seed cotton is not only positive but also significant. The estimated coefficient is 0.26, which indicates short term elasticity of cotton area with respect to price of seed cotton, suggests that an increase of 1 percent in the real price of seed cotton is expected to result in 0.26 percent expansion in cotton acreage in the short run, ceteris paribus. The long run elasticity of cotton area with respect to seed cotton prices is estimated at 1.88 suggesting high response of cotton area to changes in its real prices in the long run. Thus maintaining a positive and forward looking price policy for cotton, holding other factors constant, can play an important role in expanding cotton area and increasing its production to meet the ever increasing requirements of crop for domestic consumption and exports. In the long run 1 percent increase of cotton is likely to expand cotton area by about 1.88 percent.

Cotton yield

The coefficient of the lagged yield of cotton is also positive and significant. Its magnitude is 0.27 in the short run and 1.13 in the long run. It is worthwhile to mention that farmers' experience about the obtaining yield of any crop plays a crucial role in determining its profitability and hence incentives for its further cultivation and expansion. As farmers at planting time are not aware of the yield to be obtained it is their past experience in this context which becomes important. Thus, our results suggest that if rising trend in cotton yield persists it will help farmers' expansion of its cultivation in future

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whereas falling yield, other things being the same, could have adverse impact on its cultivation

Sugarcane yield

As it was pointed out, in certain regions sugarcane an annual crop in Pakistan poses competition to both summer and Rabi crops. As farmers' allocation of area and other resources among competing crops are primarily governed by economic considerations. Sugarcane yield plays an important role in shaping its comparative economics viz. viz competing crops. The coefficient of sugarcane yield, indicating elasticity of cotton area with respect to sugarcane yield, estimated at 0.61 has a negative sign and is significant as a priori expectations and observations of the field conditions.. As per these results a 1 percent increase in the yield of sugarcane in the previous crop season, holding other factors constant, will result in 0.61 percent contraction in cotton area in the next season.

Rice yield

We have also tried to estimate the likely impact of lagged rice yields on cotton area in the country. The estimated coefficient though positive but is not statistically significant. Thus changes in rice yield are not likely to have much impact on cotton area and production in the country. As cotton and rice crop are quite different in their terms of their requirements of soil, water, weather conditions etc, the results of our analysis are not surprising.

Lagged cotton acreage

The coefficient of cotton lagged is not only positive but also highly significant. Thus, farmers experience and know how about cotton farming and its cultural practices have become to have substantial bearing on its cultivation. The magnitude of the coefficient is high, indicating a lower rate of adjustment of farmers as well as specialized nature of its cultivation requirements demanding in terms of inputs and management requirements.

The pace at which the farmers adjust the acreage under a crop in response to the movements in the factors discussed above, may be seen from the numerical values of the adjustment coefficient (β). Adjustment coefficient is calculated by one mines coefficient of lagged dependent variable. A low rate of adjustment is observed, indicating that acreage is influenced more by technological and institutional rigidities and that price inducements operate slowly and gradually. As expected, the long run elasticity with respect to lagged real price is higher than short run elasticity, which is indicative of the long run adjustment of the area under the crop.

4.2 Empirical estimates of wheat area model

The coefficients of the estimated wheat area model along with the related statistics are presented in Table-4.

Table-4. Estimated coefficients of wheat response function (1970-71 to 2006-07).

Dependent variable=Ln (wheat area).

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	5.223	3.954	1.320	0.196
Real price of wheat at time t-1	0.045	0.031	1.444	0.158
Yield of wheat at time t-1	0.164	0.064	2.548	0.016
Real price of cotton at time t	-7.54E-06	0.027	-0.000	0.999
Area planted to wheat at time t-1	0.564	0.102	5.505	0.000
R-squared	0.944	Mean dependent var		9.806
Adjusted R-squared	0.936	S.D. dependent var		0.122
S.E. of regression	0.030	Akaike info criterion		-3.996
Sum squared resid	0.028	Schwarz criterion		-3.774
Log likelihood	74.944	F-statistic		126.987
Durbin-Watson stat	1.992	Prob(F-statistic)		0

Note: All the variables are in logarithmic form.

Table-5. Diagnostic tests.

D. h Statistic	0.070
Jarque Bera	0.94 (0.62)
Reset Test	2.03 (0.16)

The results of multiple log linear regression and its short run elasticities are presented in Table-4. The explanatory power of the estimated equation as reflected by R^2 of 0.94 is quite high. The variables included in the function account for more than 90 % of the variation in wheat area during the period under reference. All the tests for model adequacy yield satisfactory results. High value

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of F- ratio testifies to the goodness of the overall equation. D-W Statistics suggests no presence of serial correlation in the residuals. Nevertheless to further confirm this we have calculated Durbin (h) statistics as well as lagged dependent variable has also been included as independent variable. The calculated Durbin (h) statistics also confirms the absence of serial correlation in the residuals. The Reset test for functional form mis-specification was below the critical value, indicating acceptance of the hypothesis of a correct functional form. The Jarque-Bera test for normality in the residuals gave a result below the critical value, thus accepting the null hypothesis about the normal distribution of residuals, with no evidence of hetroscedasticity.

The coefficients of the estimated equation which are in fact the elasticities of area with respect to the specific variables are discussed hereunder.

Lagged real price

The coefficient of real price of wheat indicating own price elasticity of wheat area is positive though significant at a somewhat lower than conventionally accepted level. The short run price elasticity of 0.045 indicates that an increase of 10 percent in the real price of wheat, other factors remaining the same, should lead to an area expansion of about 0.5 percent. Given the size of annual wheat area this will work out to a substantial increase in absolute terms.

Wheat yield

From the estimated equation it appears that wheat yield obtained in the last year, inter alia, plays an important role in farmers' decision of allocating area to wheat crop. The area elasticity with respect to yield of 0.164 is positive and highly significant, implying that an increase of one percent in the wheat yield is likely to induce farmers' to expand wheat area by 0.164 percent in the short run. The long run elasticity coefficient in this context works out to be 0.37 percent.

Current real Cotton price

As a large proportion of wheat area follows cotton and it is a common perception that high cotton prices encourage farmers to go for additional pickings of cotton at the cost of planting wheat. However, results of our empirical analysis do not seem to endorse this view point. No doubt the estimated coefficient is negative but it is extremely small and statistically insignificant.

Lagged wheat acreage

The estimated coefficient of lagged wheat area, of 0.56 is positive and highly significant. However the large size of this coefficient indicates a relatively lower rate of adjustment by the farmers as well. The pace at which the farmers adjust the acreage under a crop in response to the movements in the factors discussed above, may be seen from the numerical values of the adjustment coefficient (β) which is one minus the coefficient of lagged dependent variable i.e. 1-0.56 = 0.44. The adjustment coefficient of 0.44 in case of wheat, relatively speaking is quite large indicating rapid adjustments by the wheat farmers. It may be pointed out here that long run elasticities of wheat area with respect to various factors are greater than their corresponding short run elasticities.

4.3 Empirical estimates of sugarcane area model

The coefficients of the estimated sugarcane area response model along with the related statistics are presented in Table-6.

Table-6. Estimated coefficients of sugarcane response function (1970-71 to 2006-07).

Dependent variable=Ln (sugarcane area)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-1.570	1.295	-1.211	0.234
Real price of sugarcane at time t-1	0.229	0.114	1.999	0.054
Yield of sugarcane at time t-1	0.336	0.152	2.208	0.034
Area planted to sugarcane at time t-1	0.649	0.110	7.704	0.000
R-squared	0.846	Mean dependent var		7.653
Adjusted R-squared	0.831	S.D. dependent var		0.187
S.E. of regression	0.077	Akaike info criterion		-2.178
Sum squared resid	0.184	Schwarz criterion		-2.00
Log likelihood	42.130	F-statistic		56.808
Durbin-Watson stat	1.926	Prob (F-statistic)		0.000

Note: All the variables are in logarithmic form

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Table-7. Diagnostic tests.

D.h Statistic	0.2
Jarque Bera	1.76 (0.41)
Reset Test	2.20 (0.147)

The estimated coefficients of various variables obtained through the multiple log linear regression equation of sugarcane area as presented in Table 6 appear to be quite satisfactory and logical in terms of their size and signs. The estimated function accounts for 85 percent of the variation in the dependent variable during the period under reference, thus testifying to the overall goodness of the fitted equation which is also bone out by the high F-ratio. Other tests about the adequacy of the estimated model are also satisfactory. In view of the inclusion of lagged value of the dependent variable as one of the explanatory variable in the function we have calculated Durbin (h) statistics to test for the presence or absence of serial correlation in the error term.. The calculated value of Durbin (h) statistics does not lend support to the presence of serial correlation The value of Reset test statistics for functional form mis-specification was also found to be below the critical value, indicating acceptance of the null hypothesis of a correct functional form. The Jarque-Bera test for normality in the residuals also provided a value below the critical level thus not rejecting the null hypothesis about the normality of the distribution of residuals, and no evidence about hetroscedasticity.
The estimated coefficients in respect of the various variables included in the function are discussed below:

Lagged real price

The elasticity coefficient of sugarcane area with respect to its real price in the last year, used in the function in lieu of its expected price at harvest time, is positive and statistically significant. The coefficient implies that one per cent increase in the real price of sugarcane, holding other variables as constant, is expected the farmers' to expand its area by 0.22 per cent in the short run. The long run price elasticity of sugarcane area works out to be 0.65 per cent which is much larger; three times the coefficient of the short run elasticity.

Sugarcane yield

The coefficient of lagged yield of sugarcane is quite large 0.33, positive, and statistically significant. From this result it appears that higher yield of sugarcane leads to larger area of the crop in the next year. This happens on two counts: higher yield leads to greater income from the crop improving its competitiveness viz. a viz other crops. Accordingly farmers' are motivated to expand its area in the next season either through planting new crop, or through more rationing or through both these methods. As per estimated results 1 percent increase in the yield of sugarcane will lead the farmers to expand its area by 0.33 percent in the next season.

Lagged sugarcane acreage

The coefficient of sugarcane lagged area is quite large, 0.64, positive and highly significant. Thus experience in cultivation of sugarcane, its management and technology seems to be playing an important role in expanding its cultivation. This may also be due to the high incidence of rationing practiced by sugarcane farmers in Pakistan.

The pace at which the farmers adjust the acreage under a crop in response to the movements in the factors discussed above, may be seen from the numerical values of the adjustment coefficient (β). The magnitude of the coefficient is 0.64 indicating that the value of β is 0.36. A possible explanation for this relatively slow adjustment in sugarcane crop may be its longer duration and rationing practices and farmers' tendency to save on seed and sowing costs or lack of viable options in some of the sugarcane farming areas may be the technical characteristics of agricultural production in Pakistan. As expected, the long run elasticities are higher than short run elasticities, which is indicative of the long run adjustment of the area under the crop.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This study using the Nerlovian model has estimated the responses of cotton, wheat and sugarcane crops' area to changes in their prices and other relevant factors in Pakistan. Time period covered in the analysis relates from 1970-71 to 2006-07 for cotton, wheat and sugarcane crops. The coefficients of the area response models for respective crops were estimated through the Ordinary Least Squares method. The responses of these crops to changes in their own prices, as reflected in their short and long run price elasticities, along with the adjustment coefficients are summarized in Table-8.

Table-8. Estimates of short and long run elasticities and adjustment coefficients.

Crops	Short run elasticity	Long run elasticity	Adjustment coefficient
Cotton	0.263	1.090	0.241
Wheat	0.045	0.105	0.435
Sugarcane	0.229	0.653	0.350

Source: Calculated by author.

Cotton

The short run price elasticity of cotton area for the period of 1970-71 to 2004-05 has been estimated at 0.263 while the long run price elasticity works out to 1.09. As per these results real price of seed cotton has played an important role in farmers' decision of expanding or contracting cotton area during the reference period. In view of the burgeoning requirements of the textile sector for cotton in the country pricing policy aiming at favorable producer incentives can be used to influence farmers' decision in favor of cotton farming. The adjustment coefficient of 0.241 is indicative of moderate pace of adjustment in response to price movements in the long run by the farmers. It also suggests that cotton acreage is influenced more by technological and institutional factors and rigidities while price inducements and incentives operate slowly and gradually. As expected, the long run price elasticity of cotton area is higher than short run elasticity, which is indicative of the long run adjustment of the area under the crop.

Wheat

The short run price elasticity of wheat area during the study period has been calculated at 0.045 while the long run price elasticity comes to 0.105. The elasticity coefficients though small however do underline the role of producer prices in influencing the area planted to wheat crop. One of the important reasons for relatively low elasticity coefficients may be the very large area already devoted to wheat cultivation and its dominance of the cropping pattern in "Rabi" season and thus not leaving much scope for further extension of wheat area. The adjustment coefficient of 0.44, relatively speaking is quite large and indicative of rapid adjustments by the wheat farmers.

Sugarcane

The short run price elasticity of sugarcane has been calculated at 0.229 while long run elasticity comes to 0.653. These results point out the important role of prices in shaping farmers' decision on sowing and ratooning of the crop. The adjustment coefficient is calculated at 0.35 which suggest a relatively moderate pace of adjustment, by the sugarcane growers. A possible explanation for this relatively slow adjustment in sugarcane crop may be its longer duration and ratooning practices and farmers' tendency to save on seed and sowing costs or lack of viable options in some of the sugarcane farming areas. As expected, the long run elasticities are higher than short run elasticities, which is indicative of the long run adjustment of the area under the crop.

The results of our analysis have shown that farmers do respond to price incentives. However, a necessary condition in this context is the availability of incentives and opportunity to respond to such economic stimuli.

Recent policy measures aimed at enhancing the role of markets and reducing tariffs allows the domestic prices to track the developments and price movements in world commodity markets. Accordingly, it will also lead to integrate the domestic markets with world commodity markets. Nevertheless, to take full advantage of these developments and benefit the farmers it is imperative to develop the domestic market infrastructure and market intelligence and pass it on to the farmers efficiently. In the wake of increasing policy liberalization framework it has become all the more important to remove market imperfections and dismante all such barriers which thwart the development of competitive markets in the country. There is ample empirical evidence that liberalization of cotton trade has allowed cotton farmers to benefit from higher world prices which helped reduce incidence of rural poverty [Orden, David, *et al.* (2006), "The Impact of Global Cotton Markets on Rural poverty in Pakistan". Back Ground Paper: 8. Islamabad: Asian Development Bank Pakistan Resident Mission].

Thus, there is a need not to let oligoplistic and monopolistic lobbies of vested interests to highjack cotton pricing for their own ends and ensure a transparent framework in this context.

In case of wheat, the staple food crop, the major instrument of government price policy has been the announcement of minimum support price. However, in many of the years in the past, when inter district movement of the commodity was restricted, the support price became the ceiling price as competition in the market was severely curtailed and farmers, especially the small ones had no other option but to sell their produce at the government announced price. Recent policy of doing away with such restrictions and allowing private sector in wheat marketing activities has facilitated transmittal producer incentives emanating from higher market prices. Other things remaining the same, this policy should promote the cause of wheat production and needs to be sustained. The public sector monopoly in wheat market should not be allowed to return again. and all steps taken to promote competition in all activities relating to wheat marketing by providing a level field.

Given the widespread weaknesses of enforcement institutions in Pakistan, it is hard to see how the negative effects of public sector involvement in wheat market can be reduced without considerably altering or removing the interventions themselves. Improvements in monitoring and a increase of enforcement institutions may remove some of the inefficiencies and abuses in the long term but are unlikely to be effectively implemented in the short of medium term.

The obvious recommendations for policy reform are to liberalize farmgate prices, reduce the stats role in procurement. Future research should be based on how this might best be achieved. Attention should be given to the conditions that are necessary for the private sector to ways of minimizing price instability.

Economic efficiency and incentive structures prevailing in the rice-wheat crop production in Pakistan is showing ability to take advantage of market access. It is very likely that reduction of distortions in domestic markets may boost production of wheat and basmati rice in Pakistan and farmers are likely to benefit. An important prerequisite, however, is that farmers should be given the opportunity to respond to market signals. In order to transform the challenges of globalisation into opportunity, Pakistan should adopt sustainable agricultural policies by making judicious use of available resources and following an appropriate combination of government policies and market sources. Increasing productivity and profitability at the farm level for sustaining this vital production system of Pakistan is essential.

In keeping with structural reforms, output prices need to be transmitted to farmers with least distortion. Price supports and controls, which cause distortions in market signals and huge fiscal costs, need to be removed.

The price of sugarcane is an important factor impacting on its area. Thus, to save the industry from recurring crisis of short supply of sugarcane it may be desirable to do away with protection to of sugar industry allowing diversion of scarce resources to more efficient uses and promote research for the development of technology and agronomic measures resulting in higher yield of sugarcane and sugar. As the farmers' are a weaker side viz a viz the sugar mills which have a powerful lobby the government can play the role of an honest broker to safeguard the interest of all the stakeholders since sugarcane shortages not only lead to low capacity utilization of the industry and lower growth rate in the manufacturing sector but also result in higher prices for the consumers and lower tax revenues for the public exchequer.

The conclusion of all this discussion is that there are powerful monopolies or oligopolistic structures in cotton, wheat, and sugarcane markets which distort the incentives for the producers resulting in wasteful and inefficient use of national resources. There is need to remove these distortions and correct market imperfections so as to make best use of the available resources and increase farm production and improve our competitiveness in world markets. It is also important to enhance capacity for economic analysis in the country to keep abreast of the development and emerging issues and challenges facing the farm sector.

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