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Full Length Research Paper

Farmers' response to price and other factors of rice in Pakistan

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The objective of this study was to increase the understanding of the specification and estimation of rice acreage response as well as to provide instruments for agricultural policy analysis. The coefficients of the area response models for respective crops were estimated through the ordinary least squares (OLS) method. The obvious recommendations for policy reform were to liberalize farm gate prices, reduce the state's 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 by ways of minimizing price instability. In keeping with structural reforms, output prices need to be transmitted to farmers with least distortion. Price support and control, which cause distortions in market signals and huge fiscal costs, need to be removed.

Key words: Rice, acreage response, farmers, agriculture.

INTRODUCTION

Agriculture in most of the developing countries is the largest commodity producing sector: in terms of its contribution to gross domestic product (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.

Krishna (1963) and Falcon (1964) analyzed farmers' response in terms of resource allocation in India and Pakistan to changes in prices overtime. The results of their analyses indicated that farmers had been adjusting their allocation of land and other resources among crops in response to changing prices and amply supported the hypothesis of farmers' rational response to economic incentives in traditional agriculture, like other economic agents. Similarly, studies based on cross sectional data from Greece and India by Yotopoulos (1964, 1968), suggested efficient allocation of various input factors by the farmers and not much scope for increasing production through reallocation of given resources.

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 changes in the incentives. The performance of various crops over time also reflected wide variation perhaps in response to varying incentives. This study examines the performance of rice in Pakistan in terms of area/production and the role played by market incentives in this regard. Rice is the major food as well as commercial crop in the country. Pakistan grows enough high quality rice to meet both domestic demand and allow for exports of around one million tonnes per annum. It occupies about 10% of the total cropped area. It accounts for 6.1% of the total value added in agriculture and 1.3% to GDP (Economic Survey, 2005, 2006).

Pakistan is famous for producing and exporting long-grain basmati rice. In addition, it also exports a

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Abbreviations: IRRI, International Rice Research Institute; **OLS,** ordinary least squares; **GDP,** gross domestic product; **PA,** partial adjustment.

substantial quantity of coarse rice. On the average, one-third of its production is exported every year. Rice exports hovering around 2 million tons per annum have accounted for 5% of the foreign exchange earned from merchandize exports. Pakistan ranking 14th in terms of rice production in the world is 6th largest exporter of rice with 6% share in volume of rice exports. Rice farming feeds the rice mills and husking units for further processing of paddy into clean rice by separating the husk from the kernel.

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 is to increase our understanding of the specification and estimation of rice acreage response as well as to provide instruments for agricultural policy analysis. Main objectives of the study are to quantify acreage responses of rice for 1975/1976 to 2006/2007, work with relatively more dynamic approach to address the issues, estimate and compare short-and long-run elasticities, and to understand factors affecting crop supply response.

Model specification and data

Here, the nature, sources, and limitations of the data and specification issues are discussed. The empirical analysis of this study will be conducted with a sample of annual data for the rice crops within the time period of 1975/1976 to 2006/2007.

Two major types of rice: aromatic long grain (Basmati) and coarse type grouped under Irri rice originally developed at the International Rice Research Institute (IRRI) in the Philippines are cultivated during summer in Pakistan. Not many other crops compete against rice in the specialized rice growing regions of the country due to technical limitations and agro climatic conditions. But there are many areas where rice faces competition from other crops. There is also competition between long grain and coarse varieties of rice for land and other resources both in the specialized rice growing regions and other areas where rice can be cultivated.

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 the extensive review of literature, discussions with experts and knowledgeable farmers helped to identify the following factors impacting on farmer's allocation of crop area and these factors include: 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:

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)

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. Accordingly, the prices received by the growers in the last season were used as an independent variable. However, the real prices; that is, 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 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. Lagged area is also used as independent variables in the hope that it captures the effects of farmers' know how and experience with the given crop. Irri acreage is specified as:

Irri acreage = f(real price of Irri at time t-1, Irri yield at time t-1/Basmati yield at time t-1, area planted to Irri at time t-1)

Irri acreage = f(real price of Irri at time t-1, Irri yield at time t-1/Basmati yield at time t-1, area planted to Irri at time t-1)

Basmati acreage is specified as:

Basmati acreage = f(real price of Basmati at time t-1, Basmati yield at time t-1/Irri yield at time t-1, area planted to Basmati at time t-1)

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 1995/1996, 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 sources shown in Table 1.

MATERIALS AND METHODS

To empirically estimate how the quantity supplied responds to changes in its prices and other relevant variables discussed earlier, there is need to move from an economic model to a statistical model that can be estimated. With all variables in logarithmic terms for convenience of mathematical manipulations and for direct estimation of elasticities, the proposed model is explained using Nerlove's model, which describes the dynamics of agricultural supply by incorporating price expectations and/or adjustment costs. In a linear form, this relationship is expressed as:

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

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:

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

Where, P_t 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 Equation 2, it can be easily shown 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 Equation 2 into 1 and rearranging gives:

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

Where, $V_t = U_t - (1-\delta)U_{t-1}$, which is the adaptive expectation model. Considering the partial adjustment (PA) model with the assumption that desired area Q_t is a function of price (P_t) and other exogenous factors (Z_t):

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

Since desired area was unobservable, the PA hypothesis becomes:

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

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. It is noteworthy 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 Equation 5 and substituting into Equation 4 gives the PA model:

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

Combining Equations 1 and 4 gives:

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

Table 1. Sources of price data.

Price	Sources
Basmati (Paddy)	Agricultural Prices Commission
Irri (Paddy)	Agricultural Prices Commission

Where both desired area level (Q^*_t) and expected price (P^*_t) are unobservable. The substitution of Equations 2 and 5 in Equation 7 gives the estimating Equation 8.

$$Qt = \lambda\alpha + \lambda\beta Pt + \lambda\gamma Zt\text{-}1 + (1- \lambda)\ Qt\text{-}1 + \lambda Ut \quad (8)$$

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 $V_t = \lambda U_t - \lambda(1-\delta) U_{t-1}$ (Khalid and Dawson, 2002).

RESULTS AND DISCUSSION

The results of the estimated Irri and Basmati models with related statistics are presented and discussed in this section. The first stage in the examination of these results was to look for their plausibility in terms of economic theory and logic, a priori expectations of signs of the estimated coefficients and their size. The estimated models are discussed one after the other in the following paragraphs.

Empirical estimates of area response model for rice crops

Two separate models were estimated for the rice crops of Irri (coarse grain) and Basmati and the results are discussed.

Empirical estimates of Irri area model

The coefficients of the estimated model along with the related statistics are displayed in Table 2. The estimated coefficients in respect of all the variables have acceptable signs. Almost all the tests for model checking are satisfactory. The value of R^2 is 0.539, indicating that the model fit is acceptable. F ratio is quite significant indicating the joint significance of the parameters. D-W is 1.557 and according to Table 3 the corresponding Durbin (h) statistics is 0.46, which indicate that there is no evidence of serial correlation. The Reset test for functional form misspecification was below the critical value, thus null hypothesis about the correct functional form of the model cannot be rejected. As Jarque-Bera test for normality of the residuals gave a value below the critical value, therefore null hypothesis about the normal distribution of the residuals cannot be rejected.

Lagged real price: Own price elasticity is positive and insignificant in the short run. In the long run, the magnitude

Table 2. Estimated coefficients of Irri rice response function (1975-76 to 2006-07). Dependent variable = Ln (Irri area).

Variable	Coefficient	Std. error	t-Statistic	Prob
Constant	0.676	1.991	0.339	0.737
Real price of Irri at time t-1	0.166	0.134	1.233	0.228
Irri yield t-1/Basmati yield t-1	2.708	1.601	1.691	0.103
Area planted to Irri at time t-1	0.516	0.147	3.500	0.001
R-squared	0.539	Mean dependent var		7.667
Adjusted R-squared	0.465	S.D. dependent var		0.134
S.E. of regression	0.098	Akaike info criterion		-1.652
Sum squared resid	0.241	Schwarz criterion		-1.418
Log likelihood	29.784	F-statistic		7.325
Durban Watson stat	1.557	Prob (F-statistic)		0.000

All the variables are in logarithmic form.

is relatively larger. According to the results, the Irri area response is 0.166. In other words, 1% increase in the price of Irri is likely to lead to an area expansion and will only bring 0.17%. Thus, the corresponding long run elasticity is estimated at 0.34.

Ratio between Irri and Basmati yield: In certain regions, Irri and Basmati rice varieties compete with each other for land and other resources. Thus, the ratio between Irri and Basmati yields was included in the function to ascertain the impact of relatively higher yield of one on the other. The coefficient of this variable though, has a positive sign but only marginally significant. Thus, there is some evidence of higher Irri yield in relation to Basmati pushing for expansion in its area, which may occur at the cost of Basmati.

Lagged Irri acreage: The coefficient of Irri lagged acreage is not only positive but also highly significant. Thus farmers' experience and know how crop farming and its cultural practices 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 on its cultivation requirements demand, in terms of inputs and management requirements. The magnitude of the coefficient of lagged dependent variable is 0.51, which shows that the value of β is 0.49 approximately. Thus adjustment coefficient is quite large, indicative of fast adjustment of the Irri farmers to various stimuli and incentives.

Empirical estimates of Basmati area model

The coefficients of the estimated model along with the related statistics are presented in Table 4. The results of diagnostic tests for model adequacy are satisfactory. The R^2 indicates 93% of variations in dependent variable are explained by independent variables. F ratio was also highly significant, showing the overall goodness of the fit.

Table 3. Diagnostic tests.

D.h statistic	0.46
Jarque Bera	4.52 (0.10)
Reset test	1.10 (0.30)

D-W is 1.84 which is closer to 2 indicating no serial correlation, Table 5 shows that estimated Durbin (h) statistics also confirms the lack of evidence about serial correlation. The Reset test for functional form misspecification was below the critical value, testifying to the correctness of the estimated functional form. The Jarque-Bera test for ascertaining the normality in the distribution of residuals gave a value which is below the critical value, thus, implying the non rejection of the null hypothesis about their normal distribution. The estimated coefficients of the model are thus discussed.

Ratio between Basmati and Irri yield: The coefficient of ratio between Basmati and Irri yield, estimated at 0.24 has a positive sign but it is not significant. Thus, increase in Basmati yield in relation to that of Irri does not help farmers' expansion in its area. It may be on account of cultivation of Basmati being limited to certain well defined regions of its cultivation.

Lagged Basmati acreage: The coefficient of lagged Basmati acreage is positive and highly significant. The magnitude of the coefficient is highest; that is, 0.871, indicating a lowest rate of adjustment of farmers as well as specialized nature of its cultivation requirements demand 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). Here the value of β is 0.128. A low rate of adjustment was observed, indicating that acreage was influenced more by technological and

Table 4. Estimated coefficients of basmati rice response function (1975-76 to 2006-07). Dependent variable = Ln (Basmati area).

Variable	Coefficient	Std. error	t-Statistic	Prob
Constant	-0.015	1.792	-0.008	0.993
Real price of Basmati at time t-1	0.123	0.120	1.025	0.314
Basmati yield t-1/ Irri yield t-1	0.244	2.704	0.090	0.928
Area planted to Basmati at time t-1	0.871	0.094	9.245	0.000
R-squared	0.938	Mean dependent var		7.772
Adjusted R-squared	0.928	S.D. dependent var		0.296
S.E. of regression	0.079	Akaike info criterion		-2.078
Sum squared resid	0.157	Schwarz criterion		-1.845
Log likelihood	36.178	F-statistic		94.813
Durban Watson stat	1.847	Prob (F-statistic)		0.000

All the variables are in logarithmic form.

Table 5. Diagnostic tests.

D.h Statistic	0.28
Jarque Bera	0.59 (0.74)
Reset Test	0.05 (0.81)

institutional rigidities, and that price inducements operated slowly and gradually. As expected, the long run elasticity with respect to lagged real price was higher than short run elasticity, which is indicative of the long run adjustment of the area under the crop.

Policy implications

This study using the Nerlovian model has estimated the responses of rice crops' area to changes in their prices and other relevant factors in Pakistan. Time period covered in the analysis related from 1975/1976 to 2006/2007 for rice crops. The coefficients of the area response models for crops were estimated through the OLS 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 6.

Irri rice

The cultivation of rice requires a high water delta crop which is generally confined to those areas where either canal water supplies are abundantly available in summer or where facilities for supplementary irrigation through tube-wells/wells or other means are available. Generally speaking, some of the soil in rice growing areas and climatic conditions also do not favor successful cultivation of many other crops; restricting farmers' choice in the process. This seems to be especially true for the area where Irri cultivation is concentrated as the price elasticity coefficient estimated at 0.166 was only marginally significant. The long run price elasticity was calculated at 0.344 as the adjustment coefficient works out to 0.483 in case of Irri rice.

Basmati rice

Basmati rice, a long grain aromatic variety of rice, is by and large cultivated in the Punjab. It is also demanding in terms of its water and pre and post harvest management requirements. The short run price elasticity of Basmati area during the period covered in this empirical analysis; that is, 1975/1976 to 2006/2007 has been estimated at 0.123 while the long run piece elasticity of Basmati area comes to 0.963. The price elasticity coefficient was statistically significant. These results underscore the role of prices in influencing area devoted to Basmati cultivation during the referenced period. The adjustment coefficient for Basmati rice has been calculated at 0.128, indicating a rather slow adjustment process. This, interalia, may be due to the specialized nature of the crop and its management practices both during pre- and post harvest stages.

CONCLUSIONS AND RECOMMENDATIONS

The obvious recommendations for policy reform are to liberalize farm gate prices and to reduce the state's 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 by 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

Table 6. Estimates of short and long run elasticities and adjustment coefficients.

Crop	Short run elasticity	Long run elasticity	Adjustment coefficient
Irri rice	0.166	0.344	0.483
Basmati rice	0.123	0.963	0.128

Source: Calculated by author.

boost production of 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 support and control, which cause distortions in market signals and huge fiscal costs, need to be removed.

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