Supply Response of Basmati Rice: Evidence from Pakistan

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Abstract

The study of agriculture supply response to prices has received immense prominence in recent years and is an important agenda for future research. The objective of the research is to understand the factors affecting the acreage basmati rice supply response in Pakistan covering the period from 1975-76 to 2012-13. The study empirically examines the own and cross price elasticity demand of basmati rice. The analysis of the own price and cross price elasticity indicates that a change in price of a single crop not only affects the land allocation and other resources for that particular crop but also changes the allocation of land to other crops depending upon their competitive relationship. The study concludes that own price and the price of irri rice significantly affect acreage under basmati rice. Regarding cotton the study found that the farm gate price of cotton is insignificant determinant of the basmati rice area while high price of fertilizer have negative impact on basmati rice acreage. Policy makers should formulate such a comprehensive agricultural policy that should treat all the determinants of basmati rice acreage as a group because prices of other crops like irri rice also have significant impact on acreage supply response of basmati rice. Fertilizer price has negative relation with the rice production in this regard to sustain higher rice production government should provide subsidized fertilizers to rice farmers. Technological change is at the heart of high growth strategies so there is need to evolve new high yielding varieties of basmati rice.

Keywords: Supply Response; Unit Root Tests; Fully Modified OLS; Basmati Rice; Pakistan

Introduction

Agriculture was the dominant sector of the economy in 1947. Its contribution to the Gross Domestic Product (GDP) was 53 per cent then but it declined with the passage of time: 20.9 per cent during FY 2014-15 and 21 per cent during FY 2011-12 (Economic Survey: 2011-12, 2014-15), for example. And the contribution of this sector to the GDP continues to decline as its growth

rate has been less than 4 per cent for the last five years. Some of the major reasons are: limited investment in construction and maintenance of infrastructure; poor performance of the cropping sub-sector; slow rate of technological innovation; inadequate water availability for irrigation purpose; marketing and trade restrictions; shortage of agricultural credit for small formers; pest and livestock disease problems and increasing cost of inputs etc.

Pakistan is famous for the production and export of basmati and irri rice. Basmati 385 rice, super Kernel basmati rice, D 98 basmati rice, etc are the major types of exported basmati rice. The exported types of irri rice include irri-9 long grain rice, irri-6 long grain rice, irri-386 long grain rice etc. Pakistan has to boost basmati crop production in order to meet requirements of considerable high quality exports of rice and maintain its position as rice exporting country. It needs to explore diversity in rice yield by promoting activities in research and development. Therefore, farmers should be given pure, healthy, and quality seeds, better quality of material to resist pest and insect diseases. Furthermore, in order to get high yield of rice, effective control of insects and pests, proper management of weeds, efficiency in timely sowing of nursery beds and transplantation and proper timings of harvesting and threshing with great care to avoid any mixture for the better milling recovery are essential. However, the usage of nitrogenous fertilizers must be avoided because it pollutes water resources and causes pest/insect diseases and results loss in quality of grain and yield.[1]

The present study has been conducted to achieve three objectives. To empirically examine the determinants of acreage supply of basmati rice in Pakistan; find own and cross-price elasticity demand of basmati rice; and draw some relevant policy implications based on empirical findings of the study. The remaining part of the study is organized as follows: Section 2 consists of review of selective past studies that have been conducted to estimate supply response of rice and other crops in Pakistan. Analytical framework is provided in section 3 along with the sources of the data. Section 4 contains discussion on the results of the study and section 5 concludes the study with some policy implications.

Literature Review

Ali and Flinn (1989) have estimated profit inefficiency of farm-specific basmati rice producers in Pakistan by taking samples from Punjab and observed that variable-coefficient profit frontier partially regressed using Maximum Likelihood Estimation (MLE) and Ordinary least Square (OLS)

techniques respectively. Data on management of farmers were collected on a per-plot basis by repeating visit interviews for their 1982 basmati rice crop. The production of basmati rice was concentrated in three ecologically homogenous districts namely Sheikhupura, Gujranwala, and Sialkot, also acknowledged as the Punjab Kalar rice tract. Sample of one hundred and twenty farmers was selected and 60 respondents from each village. The findings demonstrate that mean level of price and inefficiency at farm resources is 28 per cent, with wider range of 5 per cent to 87 per cent. There was average loss of Rs. 1222 per hectare. Socio-economic factors that are related to loss of profit are the non-agricultural employment, education of farm household and a credit constraint. However, Institutional determinants of loss of profit are the late application of fertilizer and a water constraint. The benefits of increasing efficiency of farmers are large in Punjab as a reduction of 25 per cent in loss of profit for producers of basmati rice might generate extra profits of worth Rs. 240 million in each season of rice.

Hussain et al. (2007) analyse factors that affect supply of rice in Punjab, Pakistan. Time series data pertaining to rice zone in Punjab covers the period from 1970 to 2001, have been used in the study for the variables basmati area includes production, rice yield, average of whole prices of irri and basmati rice, rainfall, canal withdrawals and fertilizer prices. Co- integration and Error Correction Model (ECM) techniques have been used to estimate the supply equation. Results show that farmers in Punjabi are price responsive. The price of own basmati rice, water availability of Kharif and rainfall have positive effect on basmati yield and acreage while irri price affects the basmati acreage negatively. The elasticity of long run supply are consistent and quite robust with the theory of economics.

Mahmood et al. (2007) observed factors responsible for oscillation in basmati rice area in Punjab, Pakistan. Time series data have been taken for the period 1982 to 2002 for area, real prices, yield, etc. in the study. Basmati rice acreage is taken as dependent variable. The explanatory variables are in lagged form and include irri rice area, basmati area, basmati real price, yield of basmati rice, and real price of irri. The goodness of fit and diagnostic tests shows that performance of estimated equation is acceptable. The quite high value of adjusted R^2 is quite high; it indicates that 84.5 per cent variation in the model is explained by rice planted acreage. The coefficient of lagged basmati acreage is significant and positively indicates that the current year acreage is much affected as compared with last year acreage. The coefficient of basmati price is positively related with basmati rice acreage and it influences planting

decision of basmati. Likewise, the coefficient of basmati yield is positively related with basmati acreage. The cross price effects have negative signs as expected and are significant at 10 per cent suggesting the price of irri has competitive negative association with basmati acreage. Nonetheless, coefficient of irri area has negative sign but insignificant.

Mohammad et al. (2007) have examined the wheat supply response in all agro-ecological zones of Punjab, Pakistan. The Punjab has further been divided into four different agro-ecological zones namely rice, cotton, barani and mixed. The annual time series data on area, wheat, refined sugar, cotton, real prices of wheat, rainfall and withdrawals from Rabi canal during crops sowing season have collected from all zones for the period 1970-2001. The whole sale price index is used to calculate real prices used in the study. The Johansen Multivariate Cointegration (JMC) technique has been used in the study. The results showed that different elasticity exists for each zone of supply response. The price of wheat and other crops such as sugarcane and cotton has significant influence on wheat acreage while the irrigation and rainfall, among the non-price factors, have positive impact on wheat acreage during short run. The findings show that elasticity of wheat supply is inelastic both in short and long run. The own price acreage elasticity in long run are 0.46, 0.53 and 0.49 in rice, cotton and mixed zones respectively.

The responses of cotton, wheat, area of sugarcane crops, changes in their prices and other pertinent factors along with impact of rice yield on cotton area in Pakistan was examined by Nosheen and Iqbal (2008). They used the Nerlovian model for estimation of results. The study covers the time period from 1970-2007 and Ordinary Least Square (OLS) technique is used to estimate the coefficients of area response model for respective crops.

The calculated short run price elasticity for wheat was 0.045 while it was 0.105 during long run. The estimated price elasticity of cotton during short run is 0.263 per cent while the long run elasticity was 1.09. The calculated short run price elasticity of sugarcane was 0.229 while estimated long run elasticity was 0.653. The estimated coefficient is positive but insignificant. Powerful oligopolistic or monopolies structures exist in wheat, cotton and sugarcane markets that distort the inducement of producers which further result in inefficient and wasteful usage of national resources.

Akhtar (1999) argued that sugarcane remained protected in Pakistan. WTO (2008) referred that provincial governments uphold prices of sugar support in

conjunction with the Federal Government. The domestic price of sugar was some 10 to 15 per cent above parity of import in FY 2005-06 and FY 2007-08 but it was below some 5 per cent in FY 2006-07. However, farmers have been significantly supported by domestic prices of sugar in earlier years being set at some 50 to 60 per cent above world levels. Although, crop sector has been contributing almost half of the share of agricultural GDP, there has been small analytic research available on determinants of demand and supply of these crops. The researchers mainly concentrated on supply response, cost of production, and elasticity of demand. The studies on supply, cost and demand lack complete information on functions in demand and supply. Arifullah (2007) stated that the majority of the studies on production cost present estimates that are different for the same year and crop mainly due to under or over estimation. Supply response studies on Pakistan have found a good number relative to studies on other aspects; these include Falcon (1964), Ahmad and Chaudry (1987), Cumming (1975), Ali (1988) and Tweeten (1986). However, sugar cane crop has been covered by only three of these studies i.e. Ahmad and Chaudry (1987), Ali (1988) and Tweeten (1986). Moreover, these studies do not endow with econometrically estimated full supply or production functions that reflect the major supply side determinants of the crop. Consequently, fewer studies are available on demand side like Cornelisse and Kuijpers , 1987; Ahmad and Chaughary 1987; Ashfaq, Griffith and Parton, 2001; Hamid et al. 1987; and Alderman 1988 but none of these cover sugarcane crop. Hussain, Sofia and Zakir (2006), while analyzing the economics of sugarcane production in Pakistan using Policy Analysis Matrix (PAM) argued that in production of sugar, Pakistan has no comparative advantage at export parity prices but suggests that crop of sugarcane might produce an import substitution crop in order to meet the demand of sugar industry. As far as specific problems confronting supply and demand determinants of sugarcane crop are concerned, there is hardly any research literature available pertaining to Pakistan.

ANALYTICAL FRAMEWORK

The Econometric Model

The supply response knowledge greatly helps in farm decision making regarding resources allocation in right direction. It can help policy makers and planners to achieve and allocate production targets and planning during long term. The models of supply response are used to forecast the upcoming agriculture foods supply. Consequently, it provides a framework for adjustment of production to the optimum resource employment promote

economic development. A simplified acreage response function used by researchers might be represented by the following expression

$$A = f(P, X) \quad (1)$$

Where A is the planted acreage of the commodity, P is the price of the commodity, and X is a set of variables affecting supply of commodity.

General form of our acreage supply equation can be written as:

$$ABR_t = f(ABR_{t-1}, FGPBR_{t-1}, FGPIR_{t-1}, FGPC_{t-1}, FGPF_{t-1}, Tech)$$

Specific form of acreage supply equation may be written as:

$$LABR_t = \beta_0 + \beta_1 LABR_{t-1} + \beta_2 LFGPBR_{t-1} + \beta_3 LFGPIR_{t-1} + \beta_4 LFGPC_{t-1} + \beta_5 LFGPF_{t-1} + \beta_6 Tech_t + \mu_t \quad (2)$$

LBA t = Natural log of current year basmati area (000 hec)

$LABR_{t-1}$ = Natural log of lagged basmati acreage (000 hec)

$LFGPBR_{t-1}$ = Natural log of lagged farm gate price of basmati rice (Rs/40kg)

$LFGPIR_{t-1}$ = Natural log of lagged farm gate price of irri rice (Rs/40kg)

$LFGPC_{t-1}$ = Natural log of lagged farm gate price of cotton (Rs/40kg)

$LFGPF_{t-1}$ = Natural log of lagged farm gate price of fertilizer (Rs/40kg)

$Tech_t$ = Technology which is proxied by time i.e.,

1975-06=1, 1976-07=2, 1977-08=3,.....2012-13=38

μ_t = Error term

As the study will estimate the log-log model given in equation (2), therefore, slope coefficient β_2 measures the own price elasticity of basmati rice acreage with respect to farm gate price of basmati rice. Slope coefficients β_3 and $\beta_4$measure the cross price elasticity of basmati rice acreage with respect to farm gate price of irri rice and farm gate price of cotton. B_5 measures the cross price elasticity of basmati rice acreage with respect to price of fertilizer.

Data Sources and Transformation

The required data have been sourced from Agriculture Statistics of Pakistan and Pakistan Economic Survey, Finance Ministry, Islamabad. According to Ali (2000) as farm gate prices are not readily available by a rule of thumb, they are calculated from wholesale prices reported in Agriculture Statistics of Pakistan and Pakistan Economic Survey by assuming that farm gate prices are uniformly 20 per cent lower than the wholesale prices. According to Mahmood et al. (2007), lagged area of basmati rice is used in the study because farmers mostly make decisions of future year's area on the basis of previous year's area allocation and it also captures the effects of farmers experience with the given crop. The study covers the time period from 1975-06 to 2012-13. Data for all variables are transformed into logarithmic form

except technology as time trend has been used as a proxy for technology variable in the study.

Estimation Technique

Time series data generally endure from the problem of unit root which may lead to spurious regression between the variables. Considering this in view, before estimating the model (2), the data have been first checked for stationarity. In this regard, the study has used Augmented Dicky-Fuller (ADF) test. After checking stationarity of data, next pace is to estimate long run relationship among supply of basmati rice per acreage for model (2). Several econometric techniques are available to study such association. However, the present study has used Philips and Hansen (1990) Fully Modified Ordinary Least Squares (FMOLS).

Results and Discussion

This section of the research is most important as it will help us to empirically find and discuss the nature of relationship between the variables given in the acreage supply response model (2). As the study had used the time series data, therefore, first of all checking the stationarity of the variables is essential. To this end, table 1 reports the results of ADF unit root test. All the variables included in the study are non-stationary at level but they become stationary at first difference i.e., they are all integrated of order [1(1)].

Table 1: ADF Unit Root Test Results

Variables	Level		First difference		Order of integration
	t-statistics	p-value	t-statistics	p-value	
LABR	-1.192	0.668	-6.259	0.000	I(1)
LFGPBR	0.466	0.983	-7.102	0.000	I(1)
LFGPC	-0.240	0.924	-8.168	0.000	I(1)
LFGPIR	0.623	0.988	-6.585	0.000	I(1)
LPF	2.120	0.999	-4.232	0.002	I(1)

After checking the stationarity of the time series under the analysis, the model (2) is estimated using the Fully Modified Ordinary Least Square (FMOLS) estimation technique which is a uni-variate cointegration technique. Results are listed in table 2. Coefficient of lagged area of basmati rice ABR (-1) has positive relationship with current year basmati acreage (ABR) and it is significant at 1 per cent level. Value of coefficient of ABR (-1) is 0.759 showing that one per cent increase (decrease) in ABR (-1) will increases (decreases) the ABR by 0.759 per cent. This finding is consistent with the results of Chaudary (2000) that lagged acreage is found to be important

determinant of nearly all current acreage of the crops taken into analysis and seem to urge for measures conducive for making performance of crops better in terms of productivity. Furthermore the result is also in line with Mahmood et al. (2007) and Kollurmath et al. (2008).

Coefficient of lagged farm gate price of basmati rice FGPBR (-1) has a positive relationship with current year basmati acreage (ABR) and it is significant at 5 per cent level. Value of coefficient of FGPBR (-1) is 0.194 indicating that one per cent increase (decrease) in FGPBR (-1) brings 0.194 per cent increase (decrease) in ABR. This finding is in line with the results of Hussain et al. (2007) that own price of basmati rice has positive effect on basmati acreage. Likewise this result is also consistent with Mahmood et al. (2007) and Talb and Begawy (2008). Regarding cross price effects, coefficient of lagged farm gate price of irri rice [FGPIR (-1)] is negatively related with current year basmati acreage (ABR) and it is significant at 5 per cent level. The coefficient of FGPIR (-1) is -0.137, suggesting that if FGPIR (-1) increases by 1 per cent then ABR will decrease by 0.137 per cent. Similarly, if FGPIR (-1) decreases by 1 per cent then ABR will increases by 0.383 per cent. This finding supports Mahmood et al. (2007) that coefficient of lagged irri rice price has competitive inverse relationship with basmati acreage.

Coefficient of lagged farm gate price of cotton FGPC (-1) has a negative impact on current year basmati acreage (ABR) but it is insignificant. It implies that price of cotton has no effect on the area under basmati rice cultivation. Regarding lagged price of fertilizer [PF (-1)] it is found that it is negatively related to basmati rice acreage (ABR) and it is significant at 10 per cent level. Demand elasticity of ABR with respect to PF (-1) is -0.106 which indicates that if PF (-1) increases by one per cent then there will be a decrease of 0.106 per cent in ABR and vice versa. This finding supports the result of Hussain et al. (2007) that fertilizer price negatively affects the basmati acreage and yield. The result is also in line with the result of Kollurmath et al. (2008).

Technology variable has a positive relationship with the current year area under basmati rice (ABR). Coefficient of technology is significant and positive which indicates that with the evolution of technology overtime, the area under basmati rice has also increased. Complementary interventions, like improvement in technological endowments, development of water resources, market regulations and infrastructural development are regarded as potential

tools to sustain higher rice production [Danh, 2007]. In Pakistan most popular form of mechanization are power rigs, bulldozers, tractors with cultivators, tube wells, and threshers and trailers. Bulldozers, tractors and power rigs are largely handled by public sector available to farmers on subsidized rates, whereas other machines are owned by medium and large sized farmers. Machines are provided to medium term farmers on rental basis to their neighboring small farmers for their use. Medium sized farmers provide their farm machines on rental basis to their neighboring small farmers in addition to their own use. Because small farmers have limited resources due to which majority of them are using outdated technology. Rice drying and rice par-boiling technologies are required for obtaining higher rice yield that are not available in our country [Amjad and Anwar, 2003].

Table 2: Acreage Supply Response Model for Basmati Rice in Pakistan (1975-06 to 2012-13)

Dependent Variable= LABR		Observations=36
Variable	Coefficient	t-statistics
Constant	1.845**	2.183
LABR $(-1)^2$	0.759***	6.162
LFGPBR (-1)	0.194**	2.513
LFGPIR (-1)	-0.137**	-2.387
LFGPC (-1)	-0.095	-1.227
LPF (-1)	-0.106*	-1.787
TECH	0.097***	4.687
$R^2 = 0.953$	Adjusted $R^2 = 0.944$	D.W = 1.951

Note: ***,** and * indicate significance at 1 per cent, 5 per cent and 10 per cent level respectively.

Conclusion and Policy Implications

Supply response is an important research issue associated with agriculture development of Pakistan. The study of agriculture supply response to prices has received a great deal of emphasis in recent years and will continue to be an important research agenda in future. The objective of the research is to understand the factors affecting the acreage supply response of basmati rice in Pakistan covering the period from 1975-76 to 2010-11.

After detailed analysis under this research, it is concluded that own price and the price of irri rice significantly affect acreage under basmati rice. The

analysis of the own price and cross price elasticity indicates that a change in price of a single crop not only affects the allocation of land and other resources for that particular crop but also changes the land allocation of other crops depending upon their competitive relationship.

Regarding cotton, it has been found that the farm gate price of cotton is insignificant determinant of the basmati rice area. Results about the effect of fertilizer show that high price of fertilizer has a significant negative effect on the basmati rice acreage because high farm gate price of fertilizer leads to higher cost of production for basmati rice. Consequently farmers will tend to decrease the area under basmati. Also adoption of latest technology is required for higher rice production as technology has proved to be significant determinant of the basmati rice acreage. Policy makers should formulate such a comprehensive agricultural policy that should treat all the determinants of basmati rice acreage as a group. Prices of other crops like irri rice also have significant impact on acreage supply response of basmati rice. Fertilizer price has negative relation with the rice production in this regard; to sustain higher rice production government should provide subsidized fertilizers to rice farmers. Technological change is at the heart of high growth strategies so there is need to evolve new high yielding varieties of basmati rice.

In order to enhance the rice production, there should be more research on new and imported hybrid seeds. Research centers should be made to test the reliability and validity of imported seeds according to climate change conditions and rice growing land areas of Pakistan as some imported hydro seeds are not suitable to grow here. Training should be provided to farmers about new and imported hybrid seeds and use of fertilizers. Government should grant more funds for research on rice seeds suitable to grow on Pakistani land. Attention should be paid to estimate cost and benefits associated with technologies used in production of rice. Government should reduce prices of fertilizers; provide more access to canal water, subsidy on agricultural machinery and easy access to consultancy facilities. Smart loans should be provided to farmers on easy instalments. Farmers should be offered satisfactory price for their produce, up to date knowledge about market prices along with better storage facilities and improved means of transportations.

Notes

[1]http://thefinancialdaily.com/NewsSearchResult/NewsSearchDetail.aspx?NewsId=75984

[2] Detailed regression results of FMOLS are pasted in appendix.

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