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SUPPLY RESPONSE ANALYSIS OF RICE IN PAKISTAN: NORMALIZED RESTRICTED TRANSLOG PROFIT FUNCTION APPROACH

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ABSTRACT: The study was designed to estimate output supply and inputs demand elasticities of rice crop in Gujranwala, Punjab, Pakistan. Data was collected from 100 respondents using proportional allocation sampling technique. The study utilized normalized restricted translog profit function approach for data analysis. Results indicated that the farmers were price responsive. Rice own price elasticity was 1.873. The output supply elasticity of rice with respect to education, land, fertilizer price and irrigation cost were 0.169, 1.274, -0.873 and -0.953 respectively. Irrigation demand elasticity with respect to education, land, fertilizer price, irrigation cost and output price were 0.144, 1.142, -0.783, -1.842 and 1.780 respectively. Fertilizer demand elasticity with respect to education, land, fertilizer price, irrigation cost and output price were 0.023, 0.792, -1.650, -0.851 and 1.851 respectively. Lastly the elasticity of profit with respect to education, land, fertilizer price, irrigation cost and output price were 0.200, 1.101, -0.832, -1.136 and 1.920 respectively. It is recommended that government should provide consistent electricity with stable rates, so that, they irrigate their fields through electric tube wells and ultimately their cost of irrigation decreases. The study also suggests that government should stabilized fertilizer prices to encourage its application. Furthermore government should raise procurement price of rice to encourage its supply this in turn will also increase profit of the farmers.

KEYWORDS: Supply response analysis, Normalized restricted translog profit function, Rice, Punjab, Pakistan.

1 INTRODUCTION

Rice is vital staple food for most part of the world's human population, particularly in “East, South, Southeast Asia, the Middle East, Latin America, and the West Indies”. It takes second highest worldwide production after maize crop (FAO Statistics, 2010) [1]. The chief rice producing countries are “China, India, Indonesia, Bangladesh, Vietnam, Thailand, Burma, Philippines, Japan, and Brazil”. The other minor producers of rice are US, USSR, Nepal, Pakistan, Cambodia, Malaysia, the republic of Korea, Madagascar and Egypt.

Rice plays a significant role in agrarian economy of the Pakistan. Firstly, as it is second staple food and in world wide, Pakistan is consider as main rice exporter with share of world trade of 10% which is about 2 million tons export annually. Share of basmati rice of Pakistan export is 25%. Export of rice is manage by private traders, the main competitor of rice with Pakistan are Thailand, Vietnam and India. Secondly, for rural people it is an imperative source of income. In addition being a food grain, by product of rice is also used for nourishing livestock as roughages in winter period once green fodder is inadequate (Pakistan Agriculture, 2008) [2].

Production target can be achieved by providing very high support prices. As these high support prices may not practicable for Government, a more particular option is to bring more land area under rice crop and this area also allocated under modern rice varieties Farooq et al. [3].

The study results are likely to be essential used for different reasons. A consistent estimate of the supply of agricultural production with demand elasticities of inputs are of enormous importance for the accurate prediction of the responsiveness of farmers to changes in input-output prices and government taxes and therefore used for exultant agricultural programs that is reliable to nourish national requirement of development and exports. Results of the elasticities of coefficients may help to provide a solid foundation in the development of effective policies applicable to the intrusion to support production, equity, efficiency and circulation revenues finally free in the agricultural sector of the economy.

2 DATA AND METHODOLOGY

2.1 UNIVERSE, SAMPLING TECHNIQUE AND SAMPLE SIZE

This study was conducted in Gujranwala district of Punjab province, Pakistan. Three villages were randomly selected due to time and financial constraint namely Saleempura, Kohlowala and Kurotana. After the selection of villages, a total of 100 respondents were selected for interview using the proportional allocation sampling technique. As research study is based on primary data, therefore interview schedule was developed in light of the objectives of the study. Data for this study were collected from sampled respondents through face to face discussion. Shazam software was utitized for estimation.

2.2 SPECIFICATION OF EMPIRICAL MODEL

The Normalized Ristricted Translog Profit Function Approach was used, as formulated by Christensen, et al. (1971) [4] and Diewert (1973) [5].

$$\ln \Pi^*_R = \alpha_0 + \alpha_i \sum_{i=1}^{2} \ln p^*_i + 1/2 \sum_{i=1}^{2} \sum_{j=1}^{2} \gamma_{ij} \ln p^*_i \ln p_j + 1/2 \sum_{i=1}^{2} \sum_{k=1}^{2} \delta_{ik} \ln p^*_i \ln z_k + \sum_{k=1}^{2} \beta_k \ln z_k + 1/2 \sum_{k=1}^{2} \sum_{h=1}^{2} \theta_{kh} \ln z_k \ln z_h + \varepsilon_i$$

Where;

Π^*_R = Restricted profit, Π_R, normalized by the output price (P_R)
P^*_i = Price of ith input (P_i) normalized by the output price (P_R)
i = j = 1, Irrigation
= 2, Fertilizer
Z_k = Quantity of fixed input, k

k = h = 1, Area under rice crop
= 2, Average no. of schooling years per male family member above 13 years
$\alpha 0$, αi, γij, δik, βk and θkh are parameters to be estimated.
ε = Random error

For econometric estimation, irrigation and fertilizer were used as variable inputs and land under rice crop and education as fixed inputs. These variables are defined as below:

1. *Restricted profit:* restricted profit is obtained by subtracting the cost of variable inputs (irrigation cost and fertilizer cost) from total revenue. The restricted profit is then normalized by the output price.
2. *Irrigation:* irrigation input used in the model comprised of per acre irrigation cost and was normalized by the output price. It is represented by P_{Ig} in the model.

3. *Fertilizer:* Fertilizer input per farm was measured as money price of fertilizer per kilogram normalized by the output price. It was a weighted price per kilogram of fertilizer worked for all kinds of fertilizers used by the sample farmers. More specifically, it was obtained by dividing the total fertilizer expenditure per farm by the total kilogram of fertilizer used and is represented by P_F in the model.
4. *Land:* Land input was measured as the cultivated land acres operated by sample households. It is represented by Z_1 in the model.
5. *Education:* It was measured as the average number of years of schooling per male family member above 13 years of age. It is represented by Z_2 in the model.

The corresponding share equations are expressed as follows;

$$S_i = P_i x_i / \Pi_R = -\partial \ln \Pi^* / \partial \ln P^*_i$$

$$= -\alpha_i - \sum_{j=1}^{2} \gamma_{ij} \ln P^*_j - \sum_{k=1}^{2} \delta_{ik} Z_k$$

$$S_R = P_R x_R / \Pi_R = 1 + \partial \ln \Pi^* / \partial \ln P^*_R$$

$$= 1 - \sum_{i=1}^{2} \alpha_i - \sum_{i=1}^{2} \sum_{j=1}^{2} \gamma_{ij} \ln p^*_j - \sum_{i=1}^{2} \sum_{k=1}^{2} \delta_{ik} \ln Z_k$$

Where S_i is the share of ith input, S_R is the share of output, X_i denotes the quantity of input i and y_R is the level of rice output.

Since the input and output shares come from a singular system of equations (since by definition $S_R - \Sigma S_i = 1$), one of the share equations, the output share, was dropped and the profit and factor demand equations were estimated as a simultaneous system.

2.3 Estimation of elasticities

Production elasticities were calculated by using following formulae.

2.4 Input demand elasticities

The own price elasticity of demand for variable input i (η_{ii}), was estimated as:

$$\eta_{ii} = -S_i - \gamma_{ii} / S_i - 1$$

Where S_i is the ith share equation, at the sample mean.

For the cross-price elasticity of demand for ith variable input with respect to the price of jth variable input (η_{ij}), the following expression was used.

$$\eta_{ij} = -S_j - \gamma_{ij} / S_i \quad \text{for} \quad i \neq j$$

The following equation was used for estimating the elasticity of demand for variable input with respect to output price, P_R (η_{iR})

$$\eta_{iR} = S_R + \sum_{j=1}^{2} \gamma_{ij}/S_i$$

The elasticity of demand for variable input with respect to kth fixed factor, η_{ik}

$$\eta_{ik} = \beta_k + \delta_{ik} \ln \ln P^*_i + \theta_{kh} \ln Z_h - \delta_{ik}/S_R$$

2.5 Output supply elasticities

To compute the elasticity of output supply with respect to price of ith variable input ($\epsilon_{R\ i}$) the following equation was used.

$\epsilon_{Ri} = - S_i - \gamma_{ji}/S_R$

The own price elasticity (ϵ_{RR}) was calculated using the following equation

$$\epsilon_{RR} = \sum_{i=1}^{2} S_i + \gamma_{ji}/S_R$$

The elasticity of output supply with respect to fixed input k (ϵ_{Rk}) was computed as:

$$\epsilon_{Rk} = \beta_k + \sum_{i=1}^{2} \delta_{ik} \ln P^*_i + \theta_{kh} \ln Z_h + \sum_{i=1}^{2} \delta_{ik}/S_R$$

2.6 PROFIT ELASTICITIES

These are defined as:

$\partial \ln \Pi^* / \partial \ln P^*_i$

for the elasticity of profit with respect to changes in input prices and

$\partial \ln \Pi^* / \partial \ln Z_k$

for the profit elasticity with respect to changes in fixed inputs.

3 RESULTS AND DISCUSSION

3.1 DESCRIPTIVE STATISTICS OF THE VARIABLE INCLUDED IN THE ANALYSIS

Table 1 presents the descriptive statistics of variables included in the production analysis of sample farm households.

Table 1 Descriptive statistics of the variables

Variable	Unit	Mean	Standard Deviation
Price of rice	PKR*/Kg	39.40	8.70
Irrigation cost	PKR/acre	21276.70	2932.10
Price of fertilizer	PKR/Kg	37.50	10.20
Area under rice	Acre(s)	8.40	5.60
Education	Years	2.90	1.46
Restricted Profit	PKR	38666.72	10805.01

Source: Survey Data, 2011.

* PKR = Pakistani Rupees; 1 US $ = 99.70 PKR

3.2 PARAMETERS ESTIMATES OF THE NORMALIZED RESTRICTED TRANSLOG PROFIT FUNCTION

Estimated factors of the normalized restricted translog profit function and demand equations are entered in the following equations. The estimated parameters of translog profit function and input demand equations are used to calculate the elasticities of input demand and output supply in relation to the price of rice, the amount of fixed and changeable inputs prices.

The following model was estimated empirically:

$\ln \Pi^*_R = 7.255 - 0.2968 \ln P_{Ig} – 0.1125 \ln P_F + 0.5206 \ln Z_1 + 0.302 \ln Z_2 - ½\ 0.152 (\ln P_{Ig})^2$

Std errors= (1.823) (0.112) (0.018) (0.043) (0.158) (0.021)

t-ratios = (3.980) (-2.650) (-6.252) (12.107) (1.917) (-7.198)

$- ½\ 0.2406 (\ln P_F)^2 - 0.1354 \ln P_{Ig} \ln P_F + 0.1846 \ln P_{Ig} \ln Z_1 - 0.0514 \ln P_{Ig} \ln Z_2$

(0.236) (0.039) (0.056) (0.023)

(-10.194) (-3.474) (3.297) (-2.238)

$$- 0.0820\ \ln P_F \ln Z_1 + 0.015 \ln P_F \ln Z_2 - 0.1939\ \ln Z_1 \ln Z_2 - \tfrac{1}{2}\, 0.0271 (\ln Z_1)^2 + \tfrac{1}{2}\, 0.426 (\ln Z_2)^2$$

(-5.858) (0.009) (0.217) (0.012) (0.379)

(0.014) (1.771) (-0.894) (-2.262) (1.125)

$R^2 = 0.8478$ Adj. $R^2 = 0.8217$ F =116.43 DW=1.96

The coefficient of determination value (R^2) reveals that the independent variable explains 82.17% of the variation in the dependent variable. The value of F (116.43) shows that the model is generally good to fit. DW (1.96) shows that there is no auto co-relation problem. The above model was used to calculate the equation of the demand for changeable inputs ie irrigation and fertilizer.

3.3 FACTOR DEMAND EQUATIONS

DI = $- 0.2968 - 0.152\ \ln P_{Ig} - 0.135\ \ln P_F + 0.184\ \ln Z_1 - 0.051\ \ln Z_2$

Std. errors = (0.112) (0.021) (0.039) (0.056) (0.023)

t-ratios = (-2.650) (-7.198) (-3.474) (3.297) (-2.238)

Df = $-0.112 - 0.135\ \ln P_{Ig} - 0.240\ \ln P_F - 0.082\ \ln Z_1 + 0.015\ \ln Z_2$

Std. errors = (0.018) (0.039) (0.023) (0.014) (0.009)

t-ratios = (-6.252) (-3.474) (-10.194) (-5.858) (1.77)

Where D_i and D_f shows equation for demand of irrigation and fertilizer respectively. The intercept of both equations were negative. The relationship of irrigation demand with irrigation cost, fertilizer price and education is negative. But positive relationship for land the demand for fertilizer has negative relation with fertilizer price, irrigation cost and land while positive relationship is estimated with education.

3.4 CALCULATED ELASTICITIES AND THEIR ACCUSATION

Table 2 demonstrates the elasticities of input demand and supply of output in relation to price of changeable inputs, rice price and quantity of fixed inputs. Following elasticities were calculated by using translog profit function and equations of input demand

Table 2 Calculated elasticities and their accusation

Variables	Output price	Irrigation cost	Fertilizer price	Land	Education
Output	1.873	-0.953	-0.873	1.274	0.162
Irrigation	1.780	-1.842	-0.783	1.142	0.144
Fertilizer	1.851	-0.851	-1.650	0.792	0.023
Profit	1.920	-1.136	-0.832	1.101	0.200

Source: Survey Data, 2011.

The output response of farmers in the region to increase in the rice price is found to be positive and elastic, a one percent rise in the price of rice would expand the supply of rice by 1.873 percent. Increase in the rice price would also encourage direct and significant expansion in demand for variable inputs. In quantitative terms, the percent increase in demand for irrigation associated with one percent rise in rice price was 1.780 percent and for fertilizer it was 1.851 percent. Rise in the price of rice will also increase the profit of farmers in the study area; one percent increase in the price of rice will increase the profit by 1.920 percent. These results are in conformity with the results obtained by Rahman (2003).

The results of own-price elasticities for the demand of variable inputs are negative, as expected and price elastic. Irrigation demand own price elasticity is 1.842 implies that one percent increase in the cost of irrigation will decrease demand for irrigation by 1.842%. While for fertilizer the own price elasticity is -1.650, shows that one percent increase in the cost fertilizer will decrease demand by 1.65%. Similarly the effect of increase in the price of variable inputs has negative impact on the supply of rice. One percent increase in the cost of irrigation will decrease the supply of rice by 0.953%, likewise irrigation one percent increase in the cost of fertilizer will decrease supply by 0.873%. In the same way increase in the prices of variable inputs also adversely effect profit. As the elasticity of fertilizer and irrigation with respect to profit is negative, One percent increase in the cost of irrigation will decrease profit by 1.136% and for fertilizer one percent rise in fertilizer prices will decrease profit by 0.832%. This is also consistent with the findings of (Razaullah et al,. 2012) [6].

Through overall estimation, the results reveal that changes in market prices whether output or input prices effects farmer profit, rice supply and resource use. The response of farmer with changing in input or output prices was significant in the study area.

Irrigation demand elasticity with respect to fertilizer price is -0.783, which reveals that one percent increase in the price of fertilizer irrigation demand decrease by 0.783%. Similarly the elasticity of fertilizer demand with respect to irrigation cost is also negative -0.851, one percent rise in irrigation cost will decrease 0.851% demand for fertilizer. These negative elasticities show that irrigation and fertilizer are complementary inputs. Their combined application increases production synergistically.

Irrigation elasticity with respect to fixed input land is positive 1.142 implies that one percent increase in land will increase demand for irrigation by 1.142%. Fertilizer elasticity with respect to land is 0.792 shows that one percent increase in land area will increase demand for fertilizer by 0.792%. On the other hand the elasticity of irrigation and fertilizer with respect to education is 0.144 and 0.023 respectively, which reveals that substantial rise in education level of the house hold will increase demand for variable inputs. The elasticity of profit with respect to education is 0.200 implies that by increasing one percent of education level of farmers house hold their profit will increase by 0.200%.

Rice output elasticity with respect to fixed inputs land and education are positive i.e. 1.274 and 0.162 respectively. The effect of land on rice output is significant and expansion in fixed input land will not only increase supply of rice but also profit of the farmer increases significantly. On the other hand the effect of education on rice supply and profit is positive but inelastic. This is also in agreement with the estimation of (Farooq *et al*. 2001)[3].

4 Conclusion And Recommendations

The analysis shows that farmers are price sensitive prevalence and ensured equitable production and input prices is essential for preserving the incentive for farmers surged rice production the results in the study area disclose that the farmers were price responsive. Rice own price elasticity was 1.873. The output supply elasticity of rice in relation to education, land, fertilizer price and irrigation cost was (0.169, 1.274, -0.873 and -0.953). Irrigation demand elasticity in relation to education, land, fertilizer price, irrigation cost and output price was (0.144, 1.142, -0.783, -1.842 and 1.780) respectively. Fertilizer demand elasticity in relation to education, land, fertilizer price, irrigation cost and output price was (0.023, 0.792, -1.650, -0.851 and 1.851) respectively. Lastly the profit elasticity in relation to education, land, fertilizer price, irrigation cost and output price was (0.200, 1.101, -0.832, -1.136 and 1.920) respectively. The study recommends that government should provide consistent electricity with stabilize rates, so that, they irrigate their fields through electric tube wells and ultimately their cost of irrigation decreases. The study also suggests that government should stabilized cost of fertilizer to encourage its application. In addition the government should surge the procurement prices encourage its offer in turn, will also surge the profits of the farmer. However consumer should be taken of care in this regard.

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