OPTIMIZING FERTILIZER APPLICATION UNDER A RANGE OF INPUT-OUTPUT PRICES WITH SPECIAL REFERENCE TO RICE CROP IN DISTRICT SHEIKHUPURA

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The present study aimed at finding out the impact of varying fertilizer and paddy rice prices upon level of fertilizer use and rice productivity in Sheikhupura district. Data collected from 100 respondents were analysed by using Cobb-Douglas production function. The results of the study indicate that recent increase in N and P prices has reduced rice output and farmers profits upto 6.4 and 8.03% respectively. To maintain the same level of rice productivity at existing N and P prices, it is necessary to raise paddy prices from Rs. 130 to Rs. 159 per 40 kg.

INTRODUCTION

Rice productivity in Pakistan is very low as compared to several other countries. It needs to be increased to meet additional requirements of growing population and to respond to export demand. Chemical fertilizer is considered as one of the most important input to improve rice productivity. A number of studies indicated that fertilizer use has significant positive effect on the productivity of rice (Ramas, 1982; Flinn and Brien, 1985; Mangabil *et al.*, 1988). However, relative more increase in fertilizer price compared to rice price has adverse effect on its productivity (Singh *et al.*, 1976; Ahmed, 1988). Overtime cropping intensity has increased substantially, consequently no upto date information is available about the optimum quantities of N and P. Therefore, the present study was conducted to measure the impact of varying prices of fertilizer and paddy rice upon level of fertilizer use, rice productivity and farmers profits.

METHODOLOGY

The data for present study were collected from Sheikhupura district lying in famous rice growing tract. In order to minimize variation, cluster sampling technique was used. A cluster of 5 villages was selected which was a representative of parent population. In total, 100 respondents were taken for final study. Only peasant proprietor, tractor cultivated and tubewell irrigated farms having 12 to 15 acres were included in the sample. Data collected were analysed by using Cobb-douglas production function. The information about the following variables was used in the analysis:

1. Type of soil

Soil 1 = 1, if clay soil, otherwise zero
Soil 2 = 1, if heavy clay, otherwise zero

These were compared with loamy silt soil.

2. Presence of salts

Salt 1 = 1, if heavily salt affected soil, otherwise zero

Salt 2 = 1, if low salt affected soil, otherwise zero

These were compared with salt free soils.

3. Transplanting time

Trans 1 = 1, if early planting i.e. before July, otherwise zero

Trans 2 = 1, if late planting i.e. before July, otherwise zero

These were compared with recommended time of transplanting time i.e. 1st July to 15 July.

4. Fertilizer application

N = Nitrogen nutrients in kg

P = Phosphorus nutrients in kg

K = Potash nutrients in kg

5. Zinc used

Zn = 1, if zinc used, otherwise zero

6. Insect attack

Insect 1 = 1, if high insect attack, otherwise zero

Insect 2 = 1, if low insect attack, otherwise zero

These were compared with no insect attack.

7. Presence of weeds

Weed = 1, if present, otherwise zero

8. Plant population

Pop. = Plant population per acre

9. Irrigation

Irri. = Irrigation in acre inches

10. Wet cultivations

Cul W. = No. of ploughings in irrigated field

11. Dry cultivations

Cul D. = No. of ploughings in dry fields

RESULTS AND DISCUSSION

The estimates of rice production function with corresponding T-test values have been shown in Table 1. The production function containing 17 variables explained 79% of yield variation. F-value shows that overall regression equation is highly significant. Factors affecting rice production included heavy clay loam soil, irrigation, plant population, rice plantation during 1st to 15th July, puddling, fertilizer and zinc application. Factors bearing an adverse effect upon rice production came up i.e. salt presence, weed infestation and insect attack. It was also found out that number of dry cultivations given had no significant impact on rice yield.

Keeping all the variables except N and P at geometric mean level following reduced form equation was obtained to predict the rice yield:

$$Y = 12.16\,(1.11+N)^{0.10026}\,(1.11+P)^{0.06458} \quad \ldots\ldots(1)$$

To determine the optimum quantity of fertilizer application and the optimum combination of nutrients, the partial derivatives of funtion (1) with respect to each factor were equated to the respective factor product prices and were solved simultaneously, i.e.

$$1.2191616(1.11+N)^{-0.89924}\,(1.11+P)^{0.06458} = PN/PY \quad \ldots\ldots(2)$$

$$0.7852928(1.11+N)^{0.10026}\,(1.11+P)^{-0.93542} = PP/PY \quad \ldots\ldots(3)$$

Optimum levels of N and P were determined which would maximize the net benefits from rice production at alternate prices of inputs and outputs with the help of equations 2 and 3. Fertilizer pries have been increased recently without parallel increase in paddy prices. As shown in Table 2, at the old prices i.e. paddy @ Rs. 3.25 P/kg, N @ Rs. 6.70 and P @ Rs. 7.0 per nutrient kg respectively, optimum quantities of N and P

Table 1. Estimates of production function for rice

Variable	B	SEB	T	Sig. T
Soil 1	0.07989	0.02978	2.682	0.0080
Soil 2	0.12275	0.03606	3.404	0.0008
Salt 1	-0.26494	0.05572	-4.755	0.0000
Salt 2	-0.05118	0.02963	-1.727	0.0859
Trans 1	-0.01548	0.02636	-0.587	0.5577
Trans 2	-0.03980	0.02734	-1.455	0.1473
IRRI	0.40476	0.09560	4.233	0.0000
N	0.10026	0.03631	2.761	0.0061
P	0.06458	0.01588	4.066	0.0001
K	0.07307	0.01928	3.790	0.0002
Zn	0.06433	0.02074	3.102	0.0022
Cul W.	0.01087	0.01994	0.545	0.5864
Weed	0.04154	0.02359	-1.761	0.0800
Insect 1	-0.20238	0.03235	-6.257	0.0000
Insect 2	-0.03850	0.02233	-1.724	0.0864
Pop.	0.55079	0.13704	4.019	0.0001
Cul D.	-0.13086	0.02801	-4.672	0.0000
(Constant)	0.61659	0.34224	1.802	0.0726

Multiple R. = 0.88787; R. square = 0.78831; adjusted R. square = 0.78177; standard error = 0.20740; F = 120.40813; significance = 0.0.

were estimated as 41.54 and 25.23 nutrient kg per acre, rice output came to 21.87 maunds per acre and farmers net benefits were calculated as Rs. 806.90. Paddy prices being Rs. 7.8 and 8.03 per N/kg have reduced N and P fertilizer use upto 16.9 and 15.9% respectively, rice output upto 6.4% and net benefit upto 8.03%. In order to obtain the same level of productivity and fertilizer use by the farmer at the new prices of N and P, it is necessary that the paddy prices be increased from Rs. 3.25 P/kg to Rs. 3.96 P/kg i.e. Rs. 159.00 P/maund.

SUGGESTIONS

For regulating agricultural input and output, price is the major policy instrument available to Government to influence farmer's decisions about fertilizer use, choice of crops and level of agricultural production. Recent increase in N, P prices have reduced farmers net benefit upto 8.03%. To compensate the reduction in farmers profits and rice productivity, it is suggested to increase paddy prices from Rs. 3.25 per kg to Rs. 3.96 per kg.

Table 2. Input combinations that maximize profit under various prices of N, P and paddy

Price of paddy P/kg	Price of "N" Rs/N.kg	Price of "P" Rs/N.kg	Optimum quantity of N	Optimum quantity of P	Change in cost	Change in output "kg"	Change in income	Net benefit (8-6)
1	2	3	4	5	6	7	8	9
3.25	6.7	7.0	41.54 (100)	25.23 (100)	455.40 (100)	388.4 (100)	1262.30	806.90 (100)
3.25	7.8	8.03	34.51 (83.1)	21.22 (84.1)	439.60 (94.5)	363.60 (93.6)	1181.70	742.10 (91.7)
3.96	7.8	8.03	4.54	25.23	455.40	388.4	1262.30	806.90

Values in parentheses show percentages.

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