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Resource Use Efficiency In Paddy Production Under Different Sources of Irrigation in Shimoga District, Karnataka: An Analysis of Farm Level Data

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ABSTRACT *Resource use efficiency analysis assumes greater importance in ascertaining whether production at the farm level could be increased profitably to an optimum level by making reallocation of existing resource use pattern. Tank irrigated paddy farmers are using relatively lesser quantity inputs and still many of these farmers are using local variety seeds due to their inability to manage the irrigation efficiently. The estimated Cobb-Douglas production functions were significant and good fit for both canal and tank irrigated paddy. Relativelyhigher MVP was reported in canal irrigated paddy compared to tank irrigated paddy for all inputs except fertilizer and PPC. Measures like de-silting of tanks and proper bunds at the farm level could enable the farmers in efficient irrigation management which could motivate them to adopt the HYV technology and to use optimum quantity inputs.*

Paddy, un-husked rice, is one of the principal food crops in India accounting for one-third of gross cropped area under food grains during 2010-11. Rice production was 96 million tonnes in 2010-11. At present, the consumption of rice is widespread and increased at a rapid rate due to high income elasticity of demand (Mythili and Shanmugam, 2000).Planning Commission estimates that domestic demand for rice, by the end of 12th five year plan, in fiscal year 2016-17 is likely to reach around 110 million tonnes, compared to production estimates of around 98 to 106 million tonnes, shortfall of around 4-12 million tonnes. Indian Council of Agriculture Research (ICAR) found that rice yield in India may drop by around 4-6% by 2020. This effectively means that India may once again become a "ship-to mouth" nation as it was before the green revolution (http://oryza.com).

Paddy is one of the most water intensive crops. It is being cultivated under different source and methods of irrigation. Inputs use pattern and their efficiency in paddy production depends on the source and method of irrigation to the crop. Given the limited availability of irrigation potential, increasing the area under the crop is difficult.Hence, the increase in production would have to come from breakthrough in productivity and increased efficiency in production (Jayaram, et.al., 1992). Under this circumstance, the resource use efficiency analysis assumes greater importance in ascertaining whether production at the farm level could be increased profitably to an optimum level by making reallocation of existing resource use pattern (Gaddi, 1999).

Against this backdrop, in this study an attempt has been made to analyse and compare the resource use efficiency in paddy production under different sources of irrigation in Shimoga district, Karnataka State. The district spreads into two agricultural zones viz. Southern Transition Zone (STZ) and Hilly Zone (HZ). This study focused on STZ of Shimoga district. Paddy is a major crop in the zone. It accounts for 40.3 per cent of total cropped area during 2011-12. The average annual normal rainfall in the zone ranges from 897 to 1101mm. STZ of the district has 2390 tanks most of which are rain fed tanks. Canals and tanks are the major sources of irrigation to the paddy crop in the zone.

II. DATA AND METHODOLOGY

Villages of this zone were broadly classified into two category viz. predominantly canal irrigated paddy growing villages and tank irrigated paddy growing villages. Three villages were randomly selected from each category. Further, sixteen farmers were randomly selected from each village. Thus 96 farmers, 48 each from canal irrigated and tank irrigated paddy were selected. The data were collected from sample respondents for the crop season, kharif 2011-2012. The efficiency in the use of each resource or input was judged on the basis of Marginal Value Product (MVP) of a rupee spent on the respective input, neo-classical criterion. The Cobb-Douglas production function of the following specification was estimated separately for canal and tank irrigated paddy:

$$Y = a\, L^{b1}\, S^{b2}\, M^{b3}\, F^{b4} P^{b5}\, H^{b6} B^{b7} e^{u} \qquad \ldots 1$$

Where Y, L, S, M, F, P, H and B are the paddy output (quintal), paddy area (ha), expenditure (in Rs.) on seeds, Farmyard Manure (FYM), Fertiliser, Plant Protection Chemicals (PPC), Human labour and bullock labourrespectively. The intercept has been denoted by 'a' and 'b_is' are the coefficients/production elasticities of the respective inputs; and u is the random disturbance term. The Cobb-Douglas production functions on per hectare basis, as specified below in log-linear form, were estimated:

$$\ln Y = \ln a + b_1 \ln L + b_2 \ln S + b_3 \ln M + b_4 \ln F + b_5 \ln P + b_6 \ln H + b_7 \ln B + u \qquad \ldots 2$$

Where, all the variables are as defined in equation (1) except that they are on per hectare basis. The above function was estimated by using the ordinary least squares technique. The production elasticities of the different inputs were used to calculate the MVP of the respective inputs.

$$MVP_{xi} = [(b_i)\,(Y)\,(P_y)\,] / \,[X_i] \qquad \ldots .3$$

Where

MVP_{xi} = Marginal value product of ith input.

B_i = Production elasticity of the ithinput

Y = Geometric mean level of output

X_i = Geometric mean of ith input

P_y = Price of paddy.

In this study inputs are in monetary terms. Hence, the MVP of any input (Xi) is the incremental change in the total output expressed in monetary terms obtained by the additional rupee spends on X_i input keeping the expenditure on the other inputs constant.

III. RESULTS AND DISCUSSION

The geometric mean values of different inputs and output of paddy on per hectare basis are given in table 1. It is apparent from the table that the geometric mean values of all the inputs except FYM were considerably higher in canal irrigated paddy compared to those in tank irrigated paddy. The paddy yield in canal irrigated paddy was also significantly higher than in tank irrigated paddy. Tank Irrigated paddy yield was lower than the canal irrigated paddy yield by 12.4 quintal (24%).

Table 1: Geometric Mean Levels of Inputs and Output

Sl. No.	Input/Output	Canal Irrigated Paddy	Tank Irrigated Paddy
1	Seeds (Rs./ha)	1060.4	744.5
2	FYM (Rs./ha)	1660.3	1975.0
3	Fertiliser (Rs./ha)	4280.6	3050.4
4	PPC (Rs./ha)	830.1	480.2
5	Human labour (Rs./ha)	11340.4	9988.9
6	Bullock labour (Rs./ha)	5855.6	5469.8
7	Output (Qtl./ha)	51.6	39.2

The estimates of production function for canal and tank irrigated paddy are presented in table 2. A perusal of the table reveals the significance of both the production functions as proved by the significance of F value at 1 per cent probability level. The coefficient of determination (R^2) for canal irrigated (53.4 per cent) and tank irrigated paddy (66.2 per cent) production function indicated a fairly high degree of 'goodness of fit'.The regression coefficients of FYM, fertiliser and PPC were positive and significant in both production functions. The coefficient for human labour in tank irrigated paddy and bullock labour in canal irrigated paddy were also found to be positive and statistically significant. In the Cobb-Douglas production function, regression coefficients are equivalent to production elasticities. The production elasticities of all the inputs were less than unity showing the diminishing marginal productivity with respect to each of the inputs.

Table 2: Estimates of Per Farm Paddy Production Function

Sl No.	Explanatory Variables	Canal Irrigated Paddy	Tank Irrigated Paddy
1	Intercept	-2.534 (-1.357)	-4.121** (-2.328)
2.	Seeds (Rs./ha)	0.029 (0.857)	0.025 (0.238)
3	FYM (Rs./ha)	0.036* (2.900)	0.043* (3.690)
4	Fertiliser (Rs./ha)	0.141** (2.103)	0.183* (3.968)
5	PPC (Rs./ha)	0.024** (2.252)	0.026** (2.347)
6	Human labour (Rs./ha)	0.292 (1.651)	0.307** (2.270)
7	Bullock labour (Rs./ha)	0.112** (2.170)	0.131 (1.726)
8	R^2	0.534	0.662
9	F Value	8.046*	12.135*
10	Number of observations (n)	48	48

Note: 1. Figures in parentheses are calculated 't' values.
2. * and ** indicate significance at 1and 5 per cent level respectively.

The production elasticity of FYM, Fertiliser, PPC human and bullock labourwere relatively higher in the tank irrigated paddy compared to canal irrigated paddy.It is due to the fact that the quantity of all these inputs used, except FYM, in tank irrigated paddy is significantly low compared to the canal irrigated paddy. Though tank irrigated paddy farmers used relatively higher quantity of FYM compared to canal irrigated paddy farmers, its production elasticity found to be more in tank irrigated paddy.Fertiliser and FYM are being alternative sources of plant nutrients; significantly lower use of fertiliser in tank irrigated paddy might enable the FYM to capture high production elasticity.Relatively higher expenditure on seeds in canal irrigated paddy is associated with relatively higher production elasticity because increasing expenditure on seeds connected with substitution of High Yielding Variety (HYV) seeds for local varieties. Substitution of HYV seeds to local variety seeds leads to higher paddy yield.

Table 3 presents the MVP of different inputs used in paddy. These values show the addition made to total returns by an additional rupee spend on the respective input while keeping the expenditure on the other inputs constant. MVPs of all the individual inputs were found to be greater than one and hence they are being efficiently used.

Table 3. MVPs of Different Inputs in Paddy Production

Sl. No.	Inputs	Canal Irrigated Paddy	Tank Irrigated Paddy
1	Seeds	1.7	1.6
2	FYM	1.4	1.1
3	Fertiliser	2.1	2.9
4	PPC	1.8	2.6
5	Human labour	1.6	1.5
6	Bullock labour	1.2	1.1

Effective irrigation management is difficult in tank irrigated paddy area. It is because rainfall is relatively more in this area and hence there is problem of leaching out of nutrients in the flood and the paddy crop of this area may, sometimes, face moisture stress due to low rainfall. Therefore, still many of the farmers are using local variety seeds and use relatively lesser quantity of inputs in general and purchased inputs like fertilizer and PPC in particular. Canal irrigated farmers are not facing such problems and almost all of them have adopted HYV technology and they are using relatively more quantity of inputs. The quantity of fertilizer use is very much close to the Recommend Doze of Fertilizer (RDF). Hence, relatively higher MVP was reported in canal irrigated paddy compared to tank irrigated paddy for all inputs except fertilizer and PPC. The quantity of fertilizer used in tank irrigated paddy is significantly less than the RDF as a result MVP of fertilizer is relatively more in tank irrigated paddy indicating the need for the increased use of fertilizer. Similarly plant protection measures are also relatively inadequate in this region as revealed by higher MVP of PPC.

IV Conclusion

Efficient irrigation management is very difficult in tank irrigated paddy. Therefore, quantity of all the inputs used is relatively less in tank irrigated paddy compared to the canal irrigated paddy except FYM. The estimatedCobb-Douglas production functions were significant and good fit for both canal and tank irrigated paddy. Relativelyhigher MVP was reported in canal irrigated paddy compared to tank irrigated paddy for all inputs except fertilizer and PPC. Measures like de-silting of tanks and proper bunds at the farm level could enable the farmers in efficient irrigation management which

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could motivate them to adopt the HYV technology and to use optimum quantity inputs. These measures will enhance the resource use efficiency in tank irrigated paddy.

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