Universal Impact Factor0.9285:2012; 1.2210:2013

Index Copernicus
ICV 2011: 5.09
ICV 2012: 6.42
ICV 2013: 15.8
ICV 2014:89.16

NAAS Rating
2012 : 1.3;
2013-2014-2015:2.69

Received on:
30th March 2016

Revised on:
25th May 2016

Accepted on:
26th May 2016

Published on:
1st June 2016

Volume No.
Online & Print
76 (2016)

Page No.
101 to 106

Life Sciences Leaflets is an international open access print & e journal, peer reviewed, worldwide abstract listed, published every month with ISSN, RNI Free- membership, downloads and access.

ANALYSIS OF RESOURCE USE EFFICIENCY IN RICE CULTIVATION UNDER DIFFERENT IRRIGATION SYSTEMS IN TAMIL NADU

V. BALAMURUGAN* AND K. MANI**

***DEPARTMENT OF AGRICULTURAL ECONOMICS, TNAU, COIMBATORE.**

**** DEPARTMENT OF AGRICULTURAL ECONOMICS, TNAU, COIMBATORE.**

Corresponding author's e-mail: economistbala@gmail.com

ABSTRACT:

Rice growing heavily consumes fresh water. At the same time, the country's rice production has to be increased to feed the growing population and to sustain food security. Hence, much of water saving has to come from irrigation by increasing the water use efficiency at farm level. The present study seeks to analyse the resource use efficiency of rice cultivation under different systems of irrigation viz., canal, tank and well irrigation conditions. Production function was employed to evaluate the factors that influenced the yield obtained from rice cultivation through different systems of irrigation Cobb-Douglas production function was used to study the resource use efficiency. The sum of the elasticity of regression co-efficient was worked out to be 0.29, which implied a decreasing returns to scale for canal irrigated system of rice cultivation. The sum of the elasticity of regression co-efficient worked out to be 1.04, which implied an increasing return to scale for tank irrigated rice cultivation. The sum of the elasticity of regression co-efficient was worked out to be 1.02, which implied an increasing return to scale for well irrigated rice cultivation.

KEY WORD: *Rice cultivation, Canal, Tank and Well Irrigation Systems, Cobb-Douglas Production Function, Resource Use Efficiency.*

INTRODUCTION:

Water has a clear linkage to all the three development dimensions: *Environmental*, *Economic*, and S*ocial*. The challenges posed by the water scarcity necessitate the need for a sustainable policy regime that facilitates Integrated Water Resource Management (IWRM) for efficient use of water which is going to become a scarcer resource globally. The matter is assuming greater urgency as the country rapidly urbanizes and undergoes industrial transformation, and reallocation of water between urban and rural areas as a result has the potential to create social tensions and even conflicts.

If more food production can be triggered by using less water by evolving diverse appropriate situations, the water saved becomes water earned for additional area of cultivation besides increasing the physical as well as the economic productivity in terms of yield or its equivalent income over unit depth of water consumed per unit area of application.

Rice growing heavily consumes fresh water, i.e., it takes some 5000 liters of water to produce one kg of rice. Conventional cultivation of irrigated rice in the rice-rich regions of the country is done by permanent flooding with the proper height of water throughout the season. Using this method leads to the use of excessive irrigation water and low irrigation water use efficiency. Increasing or at least sustaining the productivity is of paramount importance when water has been becoming a scarce resource on account of over exploitation to meet the multifarious demands in the order of preference. At the same time, the country's rice production has to be increased to feed the growing population and to sustain food security. Hence, much of water saving has to come from irrigation by increasing the water use efficiency at farm level.

Considering the aforementioned facts, the present study seeks to analyse the resource use efficiency of rice cultivation under different systems of irrigation *viz.*, canal, well and tank irrigation conditions. The study attempts to compare farmers' responses with respect to resource use efficiency in rice production depending upon the systems of irrigation in Tamil Nadu.

METHODOLOGY:

Production Function Analysis

Production function was employed to evaluate the factors that influenced the yield obtained from rice cultivation through different systems of irrigation *viz.*, well, canal and tank irrigated systems. The Cobb-Douglas production function with the following variables was estimated for the rice cultivation following different systems of irrigation mentioned above (Meeusen *et al*, 1977). Cobb-Douglas production function was used to study the resource use efficiency. The empirical model used in this study is as follows (Senthilkumar, C and T. Alagumani, 2005);

$$\ln Y = b_0 + b_1 \ln S + b_2 \ln FYM + b_3 \ln N + b_4 \ln P + b_5 \ln K + \ln b_6 HL$$

$$+ \ln b_7 ML + \ln b_8 PPC + \ln b_9 Irrg + u$$

Where,

Y	=	Output (Kg/ha)
S	=	Seeds in (Kg/ha)
FYM	=	Farm Yard Manure (t/ha)
N	=	Nitrogen in (Kg/ha)
P	=	Phosphorous (Kg/ha)
K	=	Potassium (Kg/ha)
HL	=	Human labour (man days/ha)
ML	=	Machine power (Hp.hrs/ha)
PPC	=	Plant protection chemical and miscellaneous expenditure (Rs/ha)
Irrg	=	Irrigation (ha. cm)
u	=	Error term

b_1, b_2, b_3, b_4,........ b_9 are the output elasticities

$b_0 = \ln b_0$ = Regression Constant

RESULTS AND DISCUSSION:

The results of regression analysis for rice cultivation under canal irrigation system indicated that the R^2 (co-efficient of multiple determination) was 0.61 which would indicate that 61 per cent of the variation in the dependent variable was accounted by the selected independent variables. Among the explanatory variables, human labour and quantity of seed were found to be positively significant at 1 per cent level, which would imply that an increase in the human labour and seed rate by 1 per cent from their respective mean levels, *ceteris paribus*, would increase the rice yield by 0.70 per cent, 0.91 per cent respectively. Quantity of irrigation water was found to be positively significant at five per cent level, indicating that an increase in quantity of irrigation water by 1 per cent from the mean level, *ceteris paribus*, would increase the rice yield by 0.33 per cent. The sum of the elasticity of regression co-efficients was worked out to be 0.29, which implied a **decreasing returns to scale for canal irrigated system of rice cultivation.** This could be interpreted that one per cent increase in all inputs for rice cultivation using canal irrigation system from their respective geometric mean levels would reduce the rice yield by 0.29 per cent.

In tank irrigated system of rice cultivation, the co-efficient of multiple determinations (R^2) for the rice cultivation was 0.80. This would show that about 80 per cent of the variation in the dependent variable was accounted by the selected independent variables. N and irrigation were significant at 1 per cent level. This would imply that an increase in N and quantity of irrigation water by 1 per cent from their respective mean levels, *ceteris paribus*, would increase the yield by 0.24 per cent and 0.40 per cent respectively. It was also found that the human labour was significant at 5 per cent level of mean, i.e., by increasing the human labour by one per cent, the yield will increase by 0.35 per cent. The sum of the elasticity of regression co-efficient worked out to be 1.04, which implied an **increasing returns to scale for tank irrigated rice cultivation.** This implied that one per cent increase in all inputs for rice cultivation under tank irrigation from their respective geometric mean levels would increase the rice yield by 1.04 per cent.

irrigation water was found to be more in tank irrigation (0.40 per cent) followed by canal irrigation (0.33 per cent) and well irrigation (0.17 per cent)

In well irrigated system of rice cultivation, the co-efficient of multiple determination (R^2) was 0.66. This would show that about 66 per cent of the variation in the dependent variable was accounted by the selected independent variables. Among the explanatory variables, human labour and quantity of irrigation water were found to be positively significant at 1 per cent level, which would imply that an increase in the human labour and irrigation by 1 per cent from their respective mean levels *ceteris paribus***,** would increase the rice yield by 0.32 per cent, 0.17 per cent respectively. Farm Yard Manure and Plant Protection chemicals were found to be positively significant at five per cent and this would indicate that an increase in quantity of Farm Yard Manure and value of Plant Protection Chemicals by 1 per cent from their respective mean levels, *ceteris paribus*, would increase the rice yield by 0.12 per cent and 0.17 per cent respectively. Nitrogen had a positive impact on rice yield, indicating an increase in the quantity of nitrogen by 1 per cent from its mean level, *ceteris paribus***,** would increase the rice yield by 0.08 per cent. The sum of the elasticity of regression co-efficients was worked out to be 1.02, which implied an **increasing return to scale for well irrigated rice cultivation.** This implied that one per cent increase in all inputs for rice cultivation under well irrigation from their respective geometric mean levels would increase the rice yield by 1.02 per cent.

ISSN 2277-4297(Print)0976–1098(Online)

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Regression Estimates of Production Function for Rice Cultivation using Ordinary Least Squares Method

Sl. No.	Variables	Thanjavur (Canal)			Sivagangai (Tank)			Salem (Well)		
		Coefficient	Std. error	t value	Coefficient	Std. error	t value	Coefficient	Std. error	t value
1.	Constant	7.509*	1.154	6.508	3.855*	0.520	7.407	4.391*	0.646	6.795
2.	Human labour (man days/ha.)	0.707*	0.153	4.622	0.349**	0.156	2.232	0.323*	0.057	5.711
3.	Machine power (hp hrs/ha.)	-0.686***	0.344	-1.996	0.027 NS	0.054	0.493	0.107 NS	0.087	1.230
4.	Seed rate (kgs/ha.)	0.911*	0.191	4.781	0.052 NS	0.038	1.373	0.030 NS	0.046	0.662
5.	Farm yard manure (tonnes/ha.)	-0.334***	0.173	-1.928	-0.017 NS	0.031	-0.564	0.116**	0.044	2.654
6.	Plant protection (Rs/ha.)	0.043 NS	0.045	0.956	0.157 NS	0.129	1.213	0.166**	0.076	2.183
7.	Nitrogen (kgs/ha.)	-0.694*	0.146	-4.751	0.243*	0.063	3.886	0.081***	0.048	1.702
8.	Phosphorous (kgs/ha.)	0.036 NS	0.097	0.371	0.038 NS	0.047	0.807	0.088 NS	0.083	1.062
9.	Potash (kgs./ha)	-0.020 NS	0.115	-0.174	-0.206**	0.076	-2.720	-0.054 NS	0.063	-0.869
10.	Irrigation (ha.cm)	0.334**	0.141	2.361	0.397*	0.045	8.795	0.170*	0.080	2.142
11.	R^2	0.61			0.80			0.66		
12.	Adjusted R^2	0.56			0.78			0.62		
13.	F value	12.63*			31.88*			15.34*		
14.	Number of observations	80			80			80		

* - 1 % level of significance
** - 5 % level of significance
*** - 10 % level of significance
NS - Non significance