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Case study

Allocative efficiency in paddy cultivation in the command area of Malampuzha river valley project, India.

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Efficiency studies have a vital role in agriculture since it helps us to assess the present status as well as to explore opportunities to improve the cropping pattern for better outputs. We present here the efficiency of resources utilization in rice cultivation in the command area of the Malampuzha river valley project (MRP), Kerala examined using a modified Cobb-Douglas production function approach. The data used were collected by a custom made questionnaire filled up by interviewing 99 farmers selected randomly from the command area. With respect to the productivity of the cultivation, area under cultivation (p< 0.001), and labour (p< 0.05) were two out of ten independent variables that were positive and statistically significant. Economic efficiency of resource used in farming in the study area suggest that the farm yard manure is under-utilized, while seed, tractor, labour, plant protection chemicals, fertilizers and harvest machine are over-utilized.

Key words: Rice cultivation, allocative efficiency, resource use efficiency, Cobb-Douglas function, Malampuzha river valley project.

Introduction

The production function of a commodity can be understood by looking at its various resource utilization and efficiency factors. An efficient method of production is that which utilizes the least quantity of resources for a given quantity of output. Efficiency studies have a vital role in agriculture since it helps us to assess the present status as well as to explore opportunities to improve the cropping pattern for better outputs. Generally the economists use either allocative efficiency or technical efficiency to study the economic efficiency in agriculture. Allocative efficiency, according to Oh and Kim (1980), is the ratio between total costs of producing a unit of output using actual factor proportions in a technically efficient manner, and total costs of producing a unit of output using optimal factor proportions in a technically efficient manner.

Paddy cultivation and rice occupy special status in the economy as well as culture and traditions of the state of Kerala, India. Rice is the staple food for 31 million of people residing in the state. Rice also finds key roles in almost all rituals and festivals of the state. Autumn (Kharif, and in vernacular *Virippu*), winter (Rabbi, in vernacular *Mundakan*) and summer (Samba, and in vernacular *Punja*) are three key crops of paddy raised in the state. To achieve self-reliance in food production, immediately after independence a number of irrigation and power generation projects were conceived and executed in India. In Kerala, the southernmost state of India, almost a dozen of such river valley projects were initiated. However, as far as the state was concerned self-reliance in food crops still remains a day-dream; it is still dependent for its staple food on other states of India. According to the recent statistics, while the state requires about 4 million metric tonnes of rice per annum, hardly 0.77 million metric tonnes are produced in the state (Nair, 2004). In general, agriculture of the state experienced a sharp decline during the mid 1970s, followed by ongoing fluctuations thereafter (Mahesh, 2000). Statistics for last few decades shows declining trend of the state's rice production (Raj and Azeez, 2009a). Presently the state has 0.22 million hectares under rice cultivation. There are economical, socio-cultural and political reasons for the fall in agriculture in general and the 'rice culture' of the state in particular.

The major paddy producing areas of the state are Palakkad, Kuttanad and Kole wetlands. The rice fields of all these areas are facing serious pressures of varying nature. The fertile land of Palakkad grows the major portion of rice produced in entire state. More than ten irrigation projects in the region were commissioned to help rice cultivation. Malampuzha river valley project (MRP), the largest among all the irrigation projects of Kerala state, is one among these. The present study examines the resource utilization and resource allocation

scenario of rice cultivators in the MRP command area, using a modified Cobb- Douglas production function. The Cobb-Douglas production function is regarded as an appropriate tool for such studies since the input coefficient of the equation constitutes the respective elasticity terms (Suresh and Reddy, 2006).
Several authors studied the allocative efficiency of various agricultural projects using different models. Ogundari and Ojo (2007) studied the technical, economic and allocative efficiency of Cassava farmers of Nigeria. A similar study was conducted in Jiangsu, China by Fan (1999). Inoni (2007) explored pond fish production in Nigeria, using allocative efficiency of different inputs. Taru *et al*., (2008) studied the economic efficiency of resource inputs in groundnut production in Nigeria. Liefert *et al.,* (2003) studied the allocative efficiency of grain production in Russia, by estimating the use of fertilizers for different period of time. Suresh and Reddy (2006) studied the resource use efficiency of paddy cultivation in Peechi command area in Kerala using a modified Cobb-Douglas production function. Based on allocative efficiency analysis of the inputs in rice production process the study grouped land, labour, fertilizer and plant protection chemicals under under-utilized category while farm yard manure, seeds and tractor under over-utilized category.

Study Area

The Malampuzha Hydro electric Project (MRP) completed in 1956 harness the river Malampuzha, one of the tributaries of the river Kalpathipuzha that joins the river Bharathapuzha, the second longest (209 Km) river in the state of Kerala (Fig.1.). Although conceived as a hydroelectric project the MRP as of now is serving only as an irrigation project. The total basin area of the river Malampuzha is 150 Km^2. The MRP serves 20553 ha irrigable command area via the left and the right bank canals (Fig.2.). The 32 Km long Right Bank Canal (RBC) is with a capacity to carry 4.25 Cumecs, while 27 Km long left bank canal (LBC) can carry 21.23 Cumecs.

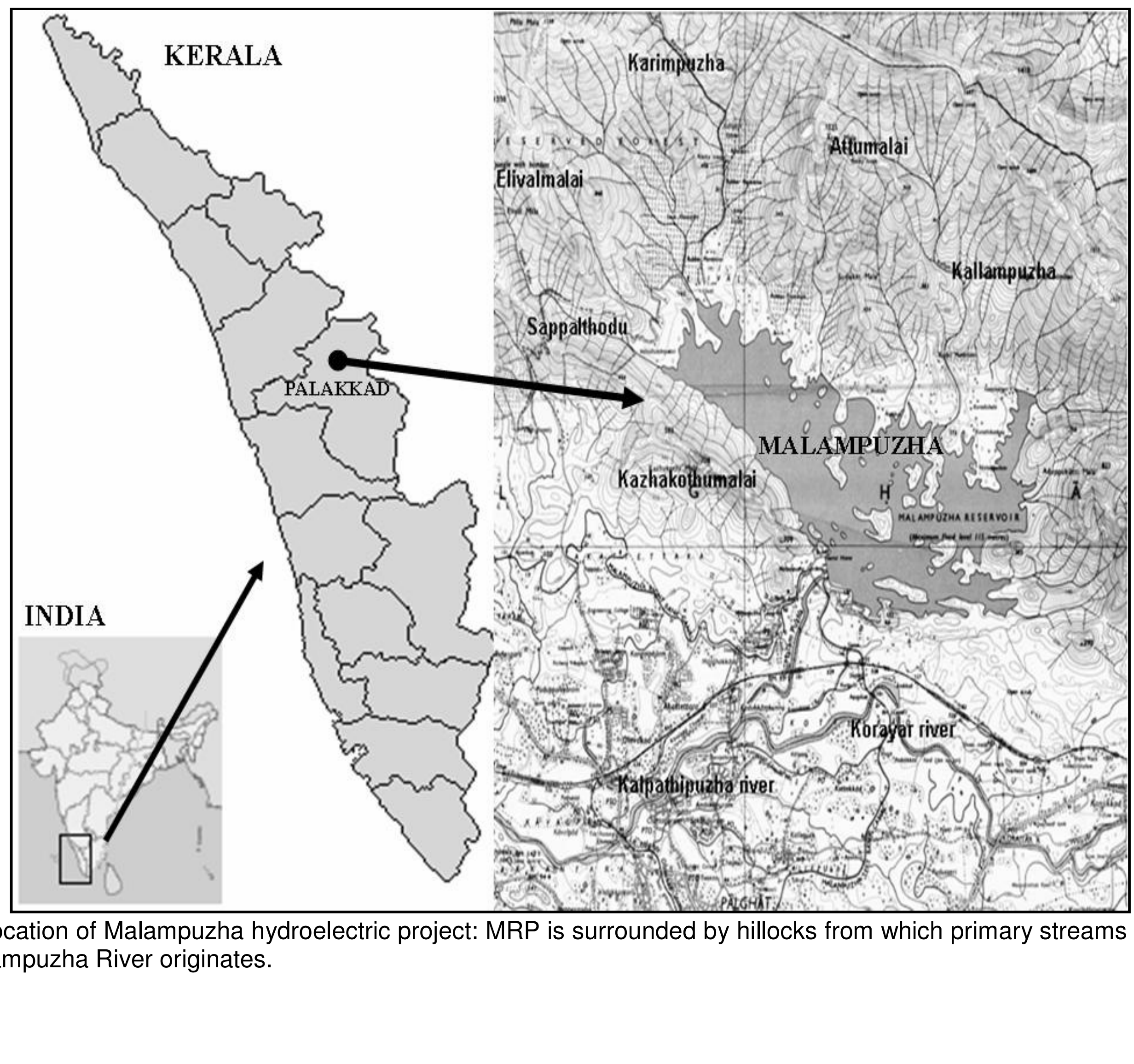

Fig.1. Location of Malampuzha hydroelectric project: MRP is surrounded by hillocks from which primary streams that joins the Malampuzha River originates.

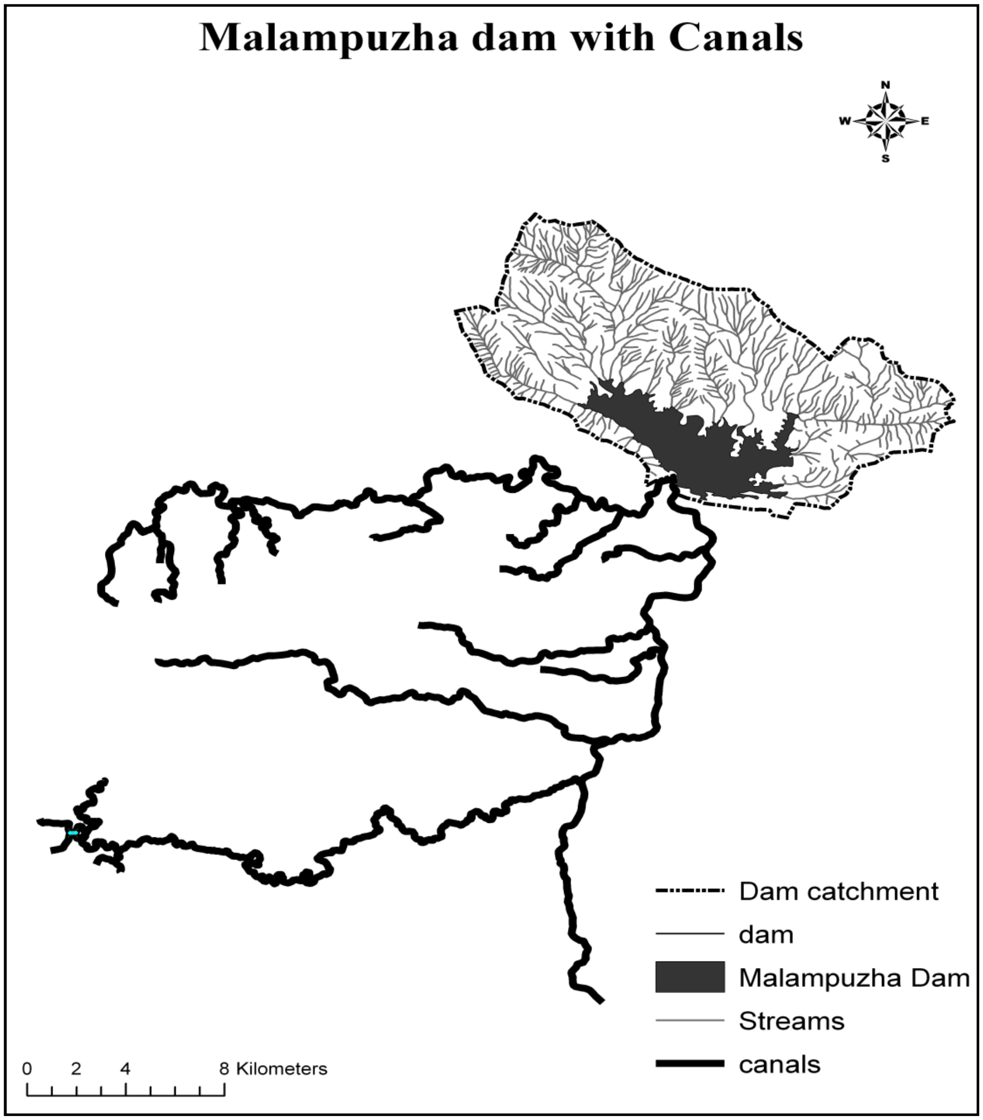

Fig.2.MRP command showing the left and right bank canals and their distributaries

Methodology

We selected the head, middle and tail locations of LBC and RBC of MRP taken according to the total length of the canals. Using Arc GIS 9.2 we marked a circular plot of 5 Km radius centering each of these locations. Inside each of these circles the major rural agriculture areas were located randomly. Using a custom made questionnaires we interviewed randomly selected farmers residing in these rural agriculture areas. 99 farmers were thus contacted and interviewed. The production function approach was adopted to determine the productivity of resources used in paddy cultivation (Suresh and Reddy, 2006; Inoni, 2007; Taru *et al*., 2008). A modified Cobb-Douglas production function including dummy variables (Suresh and Reddy, 2006) was used in this paper. The modified form of Cobb-Douglas production function used in the present study is as follows (eq. 1).

$$Y= a\,(X_1^{b1}\,X_2^{b2}\,X_3^{b3}\,X_4^{b4}\,X_5^{b5}\,X_6^{b6}\,X_7^{b7}\,X_8^{b8} e^{(b12\ D\ 1+b13\ D\ 2+\eta)}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

Where,

Y = Total yield from paddy cultivation (Rs.)
X_1 = Area under paddy cultivation (hect)
X_2 = Value of seed (Rs.)
X_3 = Tractor charges (Rs.)
X_4 = Labour charge (Rs.)
X_5 = Cost of Chemical Fertilizer (Rs.)
X_6 = Cost of Farm yard manure (Rs.)
X_7 = Cost of Plant protection chemicals (Rs.)
X_8 = Cost of Harvest machine (Rs.)
D_1 = Dummy of water stress days (value 1 for presence of stress days; 0 for Nil)
D_2 = Dummy of availability of supplementary irrigation (value 1 presence; 0 for Nil)
η = Random error
a = the intercept

b = the function coefficients

Ordinary Least Square (OLS) function was used to estimate the Cobb-Douglas function after transforming the equation as follows (eq.2)

$\ln Y = \ln a + b1 \ln X_1 + b2 \ln X_2 + b3 \ln X_3 + b4 \ln X_4 + b5 \ln X_5 + b6 \ln X_6 + b7 \ln X_7 + b8 \ln X_8 + b12 D_1 + D_2 + \eta$..............................(2)

Statistical significance of the coefficient thus obtained was checked using't' statistics. The allocative efficiency (AE) of resources employed in paddy cultivation were estimated using the coefficients in the eq (2), taken together with the Marginal Physical product (MPP), the unit (Kg) price of paddy (Py), and the unit cost of each inputs. Thus the allocative efficiency (AE) can be expressed (eq. 3) as follows:

$AE = MPPx_i * Py / Px_i$ .... (3)

Where,

$MPPx_i$ = Marginal physical product of the i^{th} input

Py = the price per unit (Kg) of paddy

Px_i = the cost per unit (Kg) of the i^{th} input

But, we know that,

$MPPx_i * Py$ = MVP (Marginal value product) and,

Px_i = MFC (Marginal factor cost)

Therefore,

AE = MVP/MFC……………………………… (4)

According to Agbamu and Fabusoro (2001), Ogundari (2008), there are three scenarios where the allocative efficiency of resources can be predicted. They are,

AE = 1, indicates the resource is optimally utilized

AE = <1, indicates the resource is over utilized

AE = >1, indicates the resource is under-utilized

Result and Discussion

The resource utilized in paddy cultivation in the MRP command area is given in table.1. For cultivating paddy in the command area the total costs of input per hectare was Rs 46045.81/-, and that could produce a yield of Rs.75635.20/-. The Benefit cost ratio of the production is 1.64 (Table.1.). The cost benefit ratio of rice cultivation in the command area suggests its high profitability. A similar study conducted in the Peechi Irrigation Command area by Suresh and Reddy (2006) of the state also revealed the high profitable nature of rice cultivation. However, the rice cultivation in the state is considered as a nonprofit making business and many farmers are diverting their land holding for other purposes including cash crop cultivation and for real estate ventures, perhaps for higher returns and for quick money. There may be several other socio-economic reasons for people in Kerala moving away from rice cultivations, which require further in-depth investigations.

Among the inputs, human labour cost accounted for the highest share (41.14%) followed by charges towards engaging tractors for preparing the land and the cost of chemical fertilizers. Mechanization of agriculture is still in its infancy in Kerala (Pillai, 2004). However, tilling land using cattle, a traditional practice in the area, has become totally absent in the MRP command area and the farmers are intensely using harvesters and have started experimenting with rice planters. Lack of agriculture labour, and high labour costs, the major problems in paddy cultivation of the state (Raj and Azeez, 2009b), are driving the farmers to more mechanization. However, the small size of land holdings, and in certain cases trade union interferences pose hurdle to mechanization. The cost of manual labour is apparently high in Kerala, as indicated by the flow of labour to the state from other parts of India. In the present study area the labour costs about Rs 200/day/person for a male worker and Rs 125 / day for a female worker. Nevertheless labour familiar with local agricultural practices are not easily available. The new National Rural Employment Guarantee program (http://india.gov.in/sectors/rural/national_rural.php),a promising socio-economic emancipation step, is said to have further reduced availability of labour for agriculture. It is found that the farmers in the MRP command area gives equal priority for both organic and inorganic fertilizers, although from the side of the government not much encouragement is given to promote organic fertilizers. No much attention is also given in the state towards organic farming (Balachandran, 2004). However, on own initiative several individual farmers and a few farmers' association are experimenting with cultivating paddy without chemical fertilizers and plant protection chemicals, as they are concerned about the presence of agrochemical residues in the final product. Several benefits of organic cultivation are being publicized by various agencies (www.keralabiodiversity.org). Nevertheless popularity of organic agriculture is still very low in the state, except among people who raise crops for own use. Organic farming in association with raising cattle and poultry can be a sustainable way of rice cultivation in the state especially for small landholdings.

Multiple regression analysis of the output with 14 input factors indicates that only the area under cultivation and the labour cost have statistically significant effects on rice production. The area under paddy cultivation showed an elasticity of 0.60, indicating that one percent increase in cultivating area would bring 0.60 percent increment in the production. The allocative efficiency for land on the other hand was found to be 0.00, indicating that it is an under utilized commodity. It is clear that the increasing land under agriculture in the MRP area would increase agriculture production. The human labour in the cultivation had a significant positive elasticity coefficient of 0.29 indicating that at current level the allocation of this resource has not yet reached the optimum level (Table.2.). Application of chemical fertilizers and the water stress days had no statistically significant influence on total yield.

The analysis of allocative efficiencies in paddy cultivation in MRP command area shows highest allocative efficiency in the case of farm yard manure. This also indicates that farm yard manure is underutilized and using more of it may increase the productivity. The allocative efficiency of seed, tractor, labour, plant protection chemical, fertilizers and harvest machine were low indicating that these resources were over utilized. The negative sign in Allocative efficiency (ALE) ratio of fertilizer indicate a negative return from per unit additional use of the commodity (Table.3.). The regular usage of chemical fertilizers would have increased the acidity of soil, which will have a negative impact on the growth and yield from rice cultivation (Arsova, 1995; Yadav *et al.,* 1998).

Conclusion

The study examines the resource use efficiency of paddy cultivation in the irrigation command area of Malampuzha river valley project (MRP), Kerala. The cost of cultivating paddy in the command area was found Rs 46046/- per hectare. The BC ratio was found 1.64. The elasticity coefficient of area under paddy cultivation, and labour was found significant and positive. The allocative efficiency analysis for resources showed that only farm yard manure (FYM) among the eight variables is under utilized.

Table.1. Inputs in paddy cultivation in the MHP command area

Inputs	Value (Rs/ha)	Percentage
Water tax	202.50	0.44
Cost of seed	3030.92	6.58
Tractor charges	8264.48	17.95
Labour cost	18944.38	41.14
Cost of chemical fertilizers	5381.74	11.69
Cost of farm yard manure	4039.62	8.77
Cost of plant protection chemicals	1467.27	3.19
Cost of harvesting machine	4714.90	10.24
Total	46045.81	
Total yield	75635.20	
B:C ratio	1.64	

Table.2. Regression results: Showing the coefficient (β) for each commodity, its level of significance (p), and the corresponding t statistics.

Variable	B value	T value	p value
Area	0.60	3.25	**0.00
Seed	0.02	0.16	0.88
Tractor	0.17	1.30	0.20
Labour	0.29	2.43	*0.02
Chemical fertilizer	-0.07	-1.16	0.25
Farm yard manure	0.01	0.46	0.65
Plant protection chemical	0.01	0.40	0.69
Harvest machine	0.03	1.38	0.17
Water stress days	-0.07	-0.46	0.65
Supplementary mode of irrigation	0.25	1.57	0.12

** Significant at 0.001; *significant at 0.05

Table.3. Allocative efficiency of resource utilized in paddy farming showing the coefficient (β) for each resources, marginal factor coast (MFC), Marginal value product (MVP), and their respective allocative efficiencies (ALE)

Variable	β value	MFC	MVP	ALE
Area	0.60	225000.00	0.89	0.00
Seed	0.02	14.64	9.22	0.86
Tractor	0.17	0.19	0.00	0.03
Labour	0.29	206.78	17.05	0.27
Fertilizer	-0.07	3.85	-25338	-6648
Farm yard manure	0.01	0.53	4.42	9.77
Plant protection chemical	0.01	1.27	14.02	0.02
Harvest machine	0.03	1400.00	3.24	0.00

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