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Economic efficiency of input utilisation of mechanised trawlers along the Kerala coast

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Abstract

In order to optimize the input utilization, the techno-economic efficiency of fishing operations is commonly assessed by employing various production function models. In view of the contribution of mechanized trawlers to the total marine fish production of India, an attempt was made to assess the input-output relationship in trawler operations at three major landing centres along the Kerala coast using the model Cobb-Douglas production function. The functional relationship indicated that there was ample scope to enhance the net profit of trawlers by increasing fishing days and area of operation at Neendakara and Munambam, whereas at Cochin Fisheries Harbour, the present operation is almost at the optimum level. At Neendakara landing centre, the fishing days in a year could be increased from the average level of 193 to 204 and in Munambam from 203 to 229 days to get the maximum profit. There is also a provision for increasing oil consumption in all three landing centers to achieve optimum level of utilisation. Even though the number of days fished in a year is not up to the optimum in all the major centers selected for the study, the existing socio-economic conflicts and inter-sectoral disputes should be addressed while increasing the number of fishing days of mechanized trawlers.

Keywords: Economic efficiency, production function, Cobb-Douglas model, trawler operation

Introduction

Estimation of techno-economic efficiency of fishing operations is a necessary prerequisite for improved utilization and optimum substitution of inputs to enhance production. Commonly employed methods for this estimate are the production function and production frontier analyses, which are based on a combination of input and output controls (Salvanes and Steen, 1994; Pascoe *et al.*, 2001). Production function defines the relationship between the level of inputs and the resultant level of outputs. It is estimated from observed outputs and input usage and indicates the average level of outputs for a given level of inputs (Schmidt, 1986). In fisheries, several estimates have been made on the production functions at either the individual boat level or total fishery level to understand the elasticities associated with inputs and in some cases, the potential for input substitution (Hannesson, 1983; Squires, 1987; Campbell and Lindner, 1990; Pascoe and Robinson, 1998). Another approach is the estimation of production frontiers, which has got convincing advantages over the estimation of production functions (Kumbhakar, 2002).

The increase in commercial fish production in India in the last five decades is mainly attributed to the introduction of mechanised trawling in the mid 1960s. Although mechanised trawling is considered as the most destructive type of mobile fishing activity (Alverson *et al.*, 1994), its contribution towards the fishery economy as well as to the livelihood of fishing communities are substantial (Gupta *et al.*, 1984). Presently these units contribute half of the total fish landings in the country (CMFRI, 2006). However, there is an increasing debate on the proliferation of mechanized trawlers and their fishing effort that affect the sustainability of marine fisheries of Kerala. Most of these are the outcome of inter-sectoral competition and subsequent socio-economic conflicts (Sathiadhas *et al.,* 1995). In 1998, there were about 30,979 trawlers along the Indian coast ranging from 9 to 17 m overall length and with engines of 40–150 HP capacity, in addition to few offshore registered trawlers of 17–30 m length and 150–400 HP engine capacity (Vivekanandan, 2003). Even though the Kalawar committee appointed by the Government of Kerala (Kalawar *et al.,* 1985) had recommended limiting the number of mechanized trawlers in the Kerala coast to about 1,145, there are about 4,550 trawlers operating in the state (Kurup, 2001). While there is scope for exploitation of under-utilized deep-sea resources in the Indian waters, analysis of the input utilization of mechanized trawlers would be of much help in maintaining the optimum level of exploitation. The objective of the present study is to estimate the output elasticities associated with selected inputs and to find out the potential of optimum utilization of inputs for enhanced production of trawl fishery along the Kerala coast, southwest coast of India.

Materials and Methods

The input-output relationship and the consequent economic efficiency of trawlers were assessed. For this, data were collected from 50 mechanised trawlers from three landing centres along the Kerala coast namely, Neendakara, Cochin Fisheries Harbour and Munambam for a period of five years from 1998 to 2003. The relationship between various inputs and the outputs of trawler operations were studied using Cobb-Douglas production function model. While several input characteristics were available in the data set (e.g. length, vessel capacity units, operating costs, labour units etc.), only the number of fishing days, quantity of fuel used, and repairing and maintenance charges per year per unit were used in the model. The production function used to evaluate the economic efficiency of input utilization in trawler operation is given below:

$Y = a.\ X_1^{b1}\ .X_2^{b2}\ .X_3^{b3}$ where,

Y	-	Gross output in kilograms
X_1	-	Number of fishing days per unit in a year
X_2	-	Quantity of fuel used in a year/unit
X_3	-	Annual repairing and maintenance charges/unit
$b1, b2, b3$	-	Regression coefficients

Marginal value productivity (MVP) was computed for all the explanatory variables X_1, X_2 and X_3 . MVP of a particular input is the addition to gross returns for the increase in one more unit of that input while other inputs are kept constant. It was obtained by multiplying the regression coefficients of explanatory variables with the ratio of geometric mean (GM) of gross returns to geometric mean of given input.

Results

Production function analysis using Cobb-Douglas model indicated that there was ample scope to enhance the net profit of trawlers by increasing the number of fishing days and area of operation. Input variables such as number of fishing days per unit and the quantity of fuel used in a year were significant in all the three landing centres. Estimation showed that one percent increase in the number of fishing days would result in an output increase by 0.78% at Neendakara, 0.69% at Cochin Fisheries Harbour and 0.72% at Munambam. The coefficient of fuel consumption was also a significant variable. An increase in oil expenditure by one percent would increase the gross output by 0.31% at Neendakara, 0.71% at Cochin Fisheries Harbour and 0.61% at Munambam (Table 1).

For the above model, the profit is maximum, when

MR = MC, where,

MR is marginal revenue and MC is marginal cost. For X_i

Table 1. *Estimated Production Function of mechanised trawlers in three landing centres along Kerala coast (Y = 0.68901)*

Parameters	Neendakara	Cochin Fisheries Harbour	Munambam
b1	0.780**	0.690**	0.720**
b2	0.312**	0.710**	0.610**
b3	-0.112 NS	0.026 NS	0.050 NS
R^2	87.2	88.0	75.0

**Significant at 5% level; NS - Not significant

MR = (Y/Xi) × PY and MC is the acquisition cost for one unit of Xi *ie*. PXi.

Hence, bi × (Y/Xi) × PY = PX_i , Optimum level of X_i = bi × Y × (PY/Xi) where,

b_i is production coefficient. Y is average annual output, X_i is the average annual input used, PY is the price of output and PX_i is the price or acquisition cost of input X_i .

It is obvious from Table 2 that the inputs for which ratio of MVP to acquisition are more than one; it can be increased from the average level. At Neendakara landing centre, fishing days in a year can be increased from the average level of 193 to 204 to get maximum profit. The annual oil consumption can be increased to the optimum level of 54,672 litres from the average of 39,814 litres. Maintenance and repairing expenditure had a negative MVP indicating that reducing the maintenance and repairing charges can increase gross returns.

For Cochin fisheries harbour, fishing days in a

Table 2. *Regression coefficients, MVP, geometric means and ratios of MVPs to their factor costs obtained through Cobb-Douglas production function analysis*

Variables	Regression coefficient	MVP of out puts (Rs.)	Geometric mean	Acquisition cost (Rs.)	Ratio of MVP to acquisition cost
Neendakara					
Y	-	-	307256 kg	-	-
X_1	0.78	14901	193 days	14070	1.06
X_2	0.312	28.89	39814 l.	20	1.445
X_3	-0.112	-0.546	Rs.63,000	1.15	-0.364
Cochin Fisheries Harbour					
Y	-	-	63168 kg	-	-
X_1	0.69	4307	192 days	4271	1.008
X_2	0.72	26.21	32064 l.	20	1.31
X_3	0.026	2.5	Rs.12,480	1.15	2.174
Munambam					
Y	-	-	87800 kg	-	-
X_1	0.63	4632	203 days	4094	1.131
X_2	0.61	22.87	39800 l.	20	1.144
X_3	0.05	3.62	Rs.20,600	1.15	3.148

year can be increased marginally from the average of 192 to 194 to get the maximum profit. Annual oil consumption can also be increased to 43,139 litres from 32,064 litres and maintenance and repairing expenditure from Rs. 12,480 to Rs. 27,091. At this landing centre, trawl units are operating almost at the optimum level, so that there is no scope for further increase in the number of fishing units or number of fishing days for the existing units. At Munambam, the fishing days in a year can be increased from the average level of 203 to 229 to get the maximum profit. The annual oil consumption can be increased to the optimum level of 45,524 litres from the average of 39,800 litres, and repairing and maintenance expenditure from Rs. 20,600 to Rs. 64,895.

Discussion

A common feature of all the production function analyses is the reliance of independent inputs to optimize the output levels. This approach has generally been common for the estimation of most production functions in several industries. However, unlike many other industries, fisheries are characterized by many mutually dependant inputs and the optimization of one variable eventually alters the other variable. For example, if the number of fishing days increases, the fuel consumption also increases proportionately. This makes the production function analysis a rather difficult task in fishing operations.

Marine fisheries of India reached maximum levels of production in the inshore areas by the end of 1990s, which has shifted the subsequent fisheries developments towards the expansion of offshore and deepsea fisheries (ICAR, 1998; Johnson, 2002). The annual catchable potential of marine fisheries of Indian waters is estimated at 3.9 million tonnes including 2.2 mt from inshore and 1.7 mt from the offshore waters (CMFRI, 2006). However, the catch from the inshore waters reached the potential estimate during 1995–2000 (Vivekanandan, 2003). While India has the potential to exploit the offshore fishery resources, majority of the trawlers are currently operating from the inshore waters. This would further put pressure on the inshore fishery resources, considering the fact that many valuable fishery resources such as catfishes, sciaenids, pomfrets, Indian mackerel and cephalopods have already been overexploited from the coastal waters (Kumar and Deepthi, 2006). Hence the expansion of trawling towards the offshore and deepsea waters would enhance the production of trawlers by utilizing maximum inputs.

From the present analysis for the optimum level of operation, the fishing days at all the three centres can be increased from the existing level whereas at Cochin Fisheries Harbour it is only marginal. Extending fishing to the offshore areas and marginally increasing the number of fishing days with an additional fuel utilisation would enhance the profit of trawlers at all the centres. On economic point of view, the production function indicates that marginal increase in fishing trips with enhanced fuel utilization is required for optimisation of profit. As far as the trawl sector is concerned, the industry is already moving towards this direction with intensified multiday trawling and extended area of operation. But sustainability of fishery resources and sectoral equity in distribution of income warrants appropriate regulatory mechanisms. Hence in order to optimise the number of fishing days to obtain maximum benefit, the production function analysis for the other major fishing units such as mechanised purse seine and gillnet units and motorised ring seine units should also be carried out. The number of fishing days for all the major fishing units operating from the landing centre may be then adjusted accordingly to obtain maximum profit. The repairing and maintenance expenses at Neendakara were beyond the optimum level, and should be reduced for the benefit of operators. Repairing and maintenance of boats is not adequate at Cochin Fisheries Harbour and Munambam. The boat owners may have to take proper steps for the timely maintenance of fishing units to increase their net benefit.

A review of Indian fishery laws and regulations reveals that their primary intent is to prevent and minimize disputes and conflicts among different sectors of the industry (James, 1992). However, most of these regulations are not based on the evaluation of economic efficiency of the fishing operations and do not seem to have included adequate provisions regarding the undertaking of responsible fishing activities, such as imposing mandatory input and/or output controls (Bhathal, 2004). Even if there is a provision of increasing the number of fishing days per year for mechanised trawlers, the existing sectoral conflicts and disputes would prevent their implementation. In this context, there are many socio-economic problems to be addressed. There is a continuing demand from the motorised as well as traditional sector to reduce the fishing days of mechanised trawlers. A further increase may result in a complex socio-economic crisis among the fishermen population of the country.

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