ISSN: 2347-5129
IJFAS 2015; 2(4): 129-134

www.fisheriesjournal.com
Received: 16-12-2014
Accepted: 20-01-2015

R. Senthiladeban
Director i/c, Staff Training Institute, Chennai, Madhavaram Milk Colony, Tamil Nadu Fisheries University, India

M. Rajakumar
Professor, Department of Fisheries Economics, Fisheries College & Research Institute (FC&RI), Tamil Nadu Fisheries University, Thoothukudi-628008, India

B.S. Viswanatha
Ph.D. Scholar, Department of Fisheries Economics, Fisheries College & Research Institute (FC&RI), Tamil Nadu Fisheries University, Thoothukudi-628008, India

Correspondence
R. Senthiladeban
Director i/c, Staff Training Institute, Chennai, Madhavaram Milk Colony, Tamil Nadu Fisheries University, India

Production economics of non mechanised fishing in the selected fish landing centres of Thoothukudi, Tamil Nadu

R. Senthiladeban, M. Rajakumar, B.S. Viswanatha

Abstract
The present study was conducted to analyse the production economics of non mechanised fishing crafts in the Therespuram, Inigo nagar and new harbour fish landing centres in Thoothukudi, Tamilnadu. These three fish landing centres were purposively selected because of the operation of only non mechanised fishing crafts. The study was restricted to owner cum operator of vallams and catamarans fitted with an outboard or inboard engine in the selected fish landing centres and the sample size was fixed at 300, equally distributed between the two craft categories. The study was carried out during the year 2012. The mean capital investment per respondent was estimated as Rs.1,72,466 for vallam with in board engine category and it was Rs.37,582 for catamaran with outboard motor category. The mean level of employment in fishing per annum was estimated at 257 days and 266 days for vallams and catamarans categories respectively. The mean total fish catch per annum was higher for vallam category accounting for 6,430.40 kg against 4,041.03 kg for catamarans. The mean annual gross income for vallam category was computed as Rs.2,60,356 and Rs.1,65,654 for vallams and catamarans. The mean total cost of fishing per annum was Rs.2,30,320 for vallams category and it was Rs.1,30,461 for catamarans. The net income on total cost basis per annum was computed as Rs. 60,631 for vallams and it was Rs.41,304 for catamarans. The regression co-efficient of depth of operation was positive and significant at p=0.01 and the actual fishing time and the gillnet length were positive and significant at p=0.05 for the vallams determining total fish catch per fishing trip for vallam category. The partial regression coefficient of fuel consumption was negative and significant at p = 0.01 and the depth of operation, length of gillnet in metres and experience of crew was positive and significant at p = 0.01 for the catamaran category.

Keywords: Capital investment, Fishing employment, Gross income, Net income, Determinants of total fish catch.

1. Introduction
The marine fish production in Tamil Nadu during the year 2011-12 was estimated at 6.30 lakh [4], contributing 10-12% of the total marine fish production in the country. The mechanised and the motorised sectors contributed 75% and 24% of the total landings respectively, while the non-mechanised sector contributed only 1%. Tamil Nadu is one of the important coastal states of India with a coast of 1076 km. The marine fisheries sector in Tamil Nadu plays a crucial role in the overall economic development of the state. There are 591 marine fishing villages and 363 marine fish landing centres in Tamil Nadu [3]. In open access unregulated marine fisheries, the viability of a fishing unit greatly influences the entry or exit of vessels in the fishing industry. The economic performance of fishing operations is affected by various factors, including fluctuations in revenue, diminishing catch per unit of effort, unforeseen increases in the cost of key inputs as well as catch and effort restrictions [2]. Innovative with fishing gears, and to withstand competition from the mechanized sector, motorized their crafts, initially with outboard engines and lately with inboard engines as well. Also, Catamaran and plank built boats have been motorized [10]. Though the traditional fishermen form the predominant fishing population, the mechanised sector contributes to more than half of the district's catch volume and even a larger share of the export earnings [5]. Fisheries sector plays a vital role in the state and provides employment to a give number of fishermen. Lack of adequate data on cost and earnings of different fishing techniques and location specific socio-economic scenario of marine fishermen are the major lacunae in planning fisheries development programmes in the region. A study of this kind, therefore, is essential to find out

the economics of fishing, the levels of employment, income and standard of living of fishermen which would help to formulate strategies for the development of marine capture fisheries in Thoothukudi district. The objectives of the study were to study the details of capital investment, items of fishing costs and the quantity and the composition of fish catch, to estimate the levels and pattern of employment and income.

2. Materials and methods

The present study was conducted in the selected three major non mechanised fish landing centres of Thoothukudi coast of Tamilnadu namely, Therespuram, Inigo nagar and new harbour. These three landing centres were purposively selected since non-mechanized fishing crafts were operated mainly from here. The sample size of fishermen respondents for the study was fixed as 300 equally distributed between the vallam and catamaran craft categories in the selected three fish landing centres. The survey schedule was prepared based on the objectives of the study and finalized after pre testing and revision. The fishermen respondents were contacted individually and the objectives of the study were explained to them before commencing data collection to ensure their co-operation. The fish catch information for different fishing seasons across different traditional boats was collected during primary data collection. The total cost was estimated by considering the total fixed cost items such as depreciation cost, interest on capital investment, repairs and maintenance cost etc. and variable cost items such as fuel, lubricant oil, crew wages, ice cost, food expenses etc. The constraints in marine fish production were ranked based on percentage responses given by the fishermen. The collected primary data were tabulated and analyzed using statistical parameters such as percentage analysis, mean, standard deviation and range appropriate statistical tools. The data for the study were collected from the fishermen respondents during February to April 2012.

3. Results and Discussion

Table 1: Details of capital investment (In Rs.)

Items of capital	Fishing craft category	
	Vallam	Catamaran
Fishing Craft		
Original cost	1,35,622±61,122 (45.07)	16,238±12,128 (74.69)
Present worth	74,111±35,798 (48.30)	8356±6353 (76.03)
Expected economic life	10 years	7 years
Engine (OBM/IBE)		
Original cost	36,844±15,396 (41.79)	21,344 ± 12,783 (59.89)
Present worth	19,756±8504 (43.05)	11,600±7132 (61.48)
Expected economic life	7 years	7 years
Fishing Gears		
Original cost	27,622±1552 (56.20)	16,556±5053 (30.52)
Present worth	14956±7769 (51.95)	9400±2736 (29.10)
Expected economic life	3 years	3 years

(The values in first row indicate mean and S.D and the figures in parentheses indicate C.V respectively).

The mean capital investment per respondent was estimated as Rs.1,35,622, varying from Rs.60,000 to Rs.2,50,000 with the C.V. of 45.07% for vallam category and it was Rs.16,238 for catamaran category, values ranged from Rs.4,000 to Rs.70,000 with the C.V. of 74.69%. The expected economic life of the vallam and catamaran was assessed as 10 years and 7 years, respectively. The present worth of a vallam at the time of survey ranged from Rs.35,000 to Rs.1,50,000 and from Rs.2,500 to Rs.38,000 for catamaran category. The mean investment cost per inboard engine was Rs.36,844 for vallam category and it came to Rs.21,344 when compared to an outboard motor for catamaran category. Its expected economic life was also estimated as 7 years.

Table 2: Levels and pattern of employment of fishermen respondents (in days)

Fishing craft category	Fishing activities			Total
	Slack season (March - June)	Moderate season (December -February)	Peak season (July - November)	
Vallam	74.47±3.49 (4.69)	67.44±1.07 (1.59)	122.53±1.44 (1.18)	257.44±5.67 (2.20)
Catamaran	74.96±3.39 (4.52)	67.67±1.12 (1.66)	123.11±1.59 (1.29)	265.56±3.63 (1.37)
Overall	74.71±3.45 (4.62)	67.56±1.10 (1.63)	122.82±1.55 (1.26)	262±3.69 (1.41)

(The values in first row indicate mean and S.D and the figures in parentheses indicate C.V respectively).

The levels and pattern of employment of fishermen respondents are given in Table 2. The mean level of employment in fishing per annum was estimated as 257 days with the C.V. of 2.20 % for vallam category. The mean level of employment varied from 252 days to 270 days per annum per respondent. The overall fish landings in terms of fish quantity were very high during the peak season (July - November), medium during moderate season (December – February) and least during the slack the season (March - June). The mean level of employment in fishing during slack, moderate and peak seasons was estimated at 74 days, 67 days and 123 days, respectively. The mean level of employment per annum for catamaran category was estimated as 266 days with the C.V. of 1.37%. The mean level of employment varied from

260 days to 272 days per annum per respondent. The mean level of employment in fishing during slack, moderate and peak seasons was reported as 75 days, 68 days and 123 days, respectively. The overall mean level of employment in fishing per annum was estimated at 262 days. The overall mean level of employment ranged from 252 days to 272 days per annum per respondent with the C.V. of 1.41%. The mean level of fishing employment per annum was 265 days for traditional fishing crafts in Tirunelveli coast, which is adjacent to Thoothukudi coast [8].

Table 3: Composition of fish catch during different fishing seasons

Season	Major fish groups landed
Slack (March – June)	Carangids, lethrinids, sardines, barracudas, snapper, tunas, seer fishes and reef cod
Peak (July – November)	Shrimps, crabs, carangids, lethrinids, sardines, barracudas, snapper, tunas, seer fishes and reef cod
Moderate (December – February)	Carangids, lethrinids, sardines, barracudas, snapper, tunas, seer fishes and reef cod

The fishing in the study area was categorized into three seasons based on fish species groups and quantity of landings. During the periods of March to June, the major fish species groups landed were carangid, lethrinid, sardine, barracuda, snapper, tuna, seer and reef cod. The fishing season was considered as slack because of low fish landings. During the periods of July to November, the fishing season was considered as peak and the major fish species groups landed in this period were shrimps and crabs along with other fish species groups. During the months of December, January and February, the fishing season was moderate with the landings of carangid, lethrinid, sardine, barracuda, snapper, tuna, seer and reef cod.

Table 4: Estimation of fish catch for different fishing seasons (in kg per annum)

Fishing craft category	Fishing seasons			Total quantity of fish catch per annum
	Slack	Moderate	Peak	
Vallam	1001.47	2058.93	3370.00	6430.40
	(15.57)	(32.02)	(52.41)	(100.00)
Catamaran	666.57	1174.13	2200.33	4041.03
	(16.50)	(29.06)	(54.44)	(100.00)
Overall	834.02	1630.03	2785.17	5249.22
	(15.89)	(31.05)	(53.06)	(100.00)

(Figures in parentheses indicate percentages to total)

The overall total mean fish catch per annum per respondent was calculated as 5,249.22 kg of which the overall fish catch during slack, moderate and peak seasons accounted for 15.89%, 31.05% and 53.06%, respectively. The mean total fish catch per annum was higher for vallam category accounting for 6,430.40 kg against 4,041.03 kg for catamarans. The percentages of fish catch during slack, moderate and peak seasons came to 15.57, 32.02 and 52.41, respectively for vallam category, whereas they were 16.50, 29.06 and 54.44 for catamaran category. The mean total fish catch of 4,999 kg per annum and the average catch per fishing trip was 18 kg for the catamarans fitted with outboard engine along Madras coast [9]. While the mean fish catch per trip ranged from 11.48 kg to 37 kg with a mean value of 22.98 kg, for catamarans in Tirunelveli coast [7].

Table 5: Estimation of levels of season-wise gross income from fishing (in Rs.)

Fishing craft category	Fishing seasons			Total gross income per annum
	Slack	Moderate	Peak	
Vallam	41382.76±6297.04	61512.62±7396.08	188056.44±7718.26	260356±46326
	28178 – 67551	50376 – 89514	162581 – 201579	28178 – 201579
	15.22	12.02	4.10	17.79
Catamaran	25455.47±6871.82	35592.62±9329.13	110717.75±6471.08	165654.27±18126.65
	9750 – 30312	13037 – 46853	92661 – 128810	9750 – 128810
	27.00	26.21	5.84	10.94
Overall	33645.25±12115.98	49052.62±16731.97	149476.92±46645.57	215745.84±43373.94
	9750 – 67551	13037 – 89514	92661 – 201579	9750 – 201579
	36.01	34.11	31.21	20.10

(The values in first, second and third rows indicate mean and S.D., range and C.V., respectively).

The overall mean annual gross income from fishing per fisherman respondent was estimated as Rs.2,15,745.84 with the C.V. of 20.10%. The values ranged from Rs.9,750 to Rs.2,01,579 per respondent per annum. The mean annual gross income for vallam category was computed as Rs.2,60,356 for which the C.V. was estimated as 17.79 %. The values ranged from Rs.28,178 to 2,01,579 per annum. The computed mean gross income from fishing during slack, moderate and peak seasons were Rs.41,382.76, Rs.61,512.62 and Rs.1,88,056.44 with the C.V. of 15.22%, 12.02 % and 4.10%, respectively, for vallam category. The mean annual gross income for catamaran category was calculated as Rs.1,65,654.27 with the values ranging from Rs.9,750 to Rs.1,28,810 and the C.V. was 10.94%. The computed mean gross income for catamaran category during slack, moderate and peak seasons was Rs.25,455.47, Rs.35,592.62 and Rs.1,10,717.75 with the C.V. of 27.00%, 26.21% and 5.84%, respectively. The high value realisation for the peak season was mainly due to the shrimp and crab catch along with the other fish species groups.

Table 6: Estimation of season-wise cost items and net income (in Rs.)

Item	Fishing craft category							
	Vallam				Catamaran			
	Slack season	Moderate season	Peak season	Amount per annum	Slack season	Moderate season	Peak season	Amount per annum
TFC	5395.35 (15.39)	4886.03 (9.63)	8877.30 (6.14)	19158.68 (8.32)	3687.28 (17.70)	3328.69 (11.52)	6055.78 (7.50)	13071.75 (10.02)
TVC	29671.83 (84.61)	45832.22 (90.37)	135657.86 (93.86)	211161.91 (91.68)	17139.61 (82.30)	25563.02 (88.48)	74687.14 (92.50)	117389.77 (89.98)
TC	35067.18 (100.00)	50718.25 (100.00)	144535.16 (100.00)	230320.59 (100.00)	20826.89 (100.00)	28891.71 (100.00)	80742.92 (100.00)	130461.52 (100.00)
Gross Income	41382.76	61512.62	188056.44	290951.82	25455.47	35592.62	110717.75	171765.84
Net Income on TVC basis	11710.93	15680.40	52398.58	79789.91	8315.86	10029.60	36030.61	54376.07

(Figures in Parentheses indicate percentages in total)

The mean total cost per annum was estimated as Rs. 2,30,320.59 for vallam category with the mean total variable cost and mean total fixed cost registering 91.68% and 8.32%, respectively. The mean total cost per annum for catamaran category was worked out to Rs.1,30,461.52 and the percentages of mean total variable cost and mean total fixed cost being 89.98 and 10.02 respectively. It could be inferred that the mean total cost was higher for peak season comparing to other two seasons with reference to both the fishing craft categories. The crew share was a major portion (more than 55%) of the total variable cost for motorised traditional crafts along Kerala coast [1].

The gross income from fishing per annum (including all the three seasons) per fisherman respondent was computed as Rs.2,90,951.82 for vallam category and it came to Rs.1,71,765.84 for catamaran category. The mean gross income estimated for vallam category during slack, moderate and peak fishing seasons was Rs.41,382.76, Rs.61,512.62 and Rs.1,88,056.44, respectively and for the catamaran category, they were Rs.25,455.47, Rs.35,592.62 and Rs.1,10,717.75 respectively. The mean total cost of fishing per annum was Rs.2,30,320.59 which was distributed as Rs.35,067.18, Rs.50,718.25 and Rs.1,44,535.16 during slack, moderate and peak seasons, respectively for vallam category. The mean total cost of fishing per annum for catamaran category was Rs.1,30,461.52, which was distributed as Rs.20,826.89, Rs.28,891.71 and Rs.80,742.92 during slack, moderate and peak seasons, respectively. The net income on the total variable cost basis per annum was computed as Rs.79,789.91 for vallam category and it was Rs.54,376.07 for catamaran category. The net income on total cost basis per annum was computed as Rs.60,631.23 for vallam category and the corresponding values of net income per annum for slack, moderate and peak seasons were Rs.6,315.58, Rs.10,794.37 and Rs.43,521.28, respectively. For the catamaran category, the mean net income on total cost basis per annum was computed as Rs.41,304.32 and the corresponding values of net income per annum for slack, moderate and peak seasons were Rs.4,628.58, Rs.6,700.91 and Rs.29,974.83, respectively. The net income per annum for the vallam and the catamaran categories was estimated as Rs.69,750 and Rs.38,000 respectively [6].

Table 7: The major constraints in marine fish production

Sl. No.	Constraints	Percentage	Ranks
1	Depletion of fish stock leading to poor fish catches	88.45	I
2	Inadequate availability of experienced crew	41.25	IX
3	Price fluctuation is erratic in fish auction	81.53.	III
4	No well-established marketing system for fish sale	59.26	VII
5	Hindrance of fleet movement by mechanised trawlers in the fishing areas of traditional fishing	71.76	V
6	Defunct state of fishermen co-operative society in the fishing villages	64.84	VI
7	Increase in the cost of fishing implements	79.27	IV
8	Lack of infrastructure facilities at the landing centres	43.18	VIII
9	Inadequate supply of institutional credit for the purchase, repairs and maintenance of fishing crafts and gears	85.68	II

3.1. Production Function Analysis

The factors determining total fish catch per fishing trip were studied by production function analysis. The linear regression (usually linear regression models cannot be applied in fisheries directly, because relationships between inputs and output need not necessarily be linear. Please try some other model. Deductions based on this model cannot be directly given and may not be logical) model was used and the estimated function for vallam category is presented below:

$$y_1 = \underset{(4.9064)}{-13.0247} + \underset{(0.9754)}{1.4367\ X_1^{NS}} + \underset{(0.8359)}{0.5863\ X_2^{NS}} + \underset{(0.5096)}{1.5192\ X_3^{**}} + \underset{(0.5223)}{1.2581\ X_4^{*}}$$

$$+ \underset{(0.4640)}{0.7150\ X_5^{NS}} - \underset{(0.6681)}{0.2930\ X_6^{NS}} + \underset{(0.0850)}{0.1570\ X_7^{NS}}$$

$R^2 = 0.8263$

F Value = 147.76

n = 150

(Figures in parentheses indicate standard error)

Where,

Y_1 = Total fish landings per fishing trip in Kg.
X_1 = Fuel consumption in litres
X_2 = Distance travelled in nautical miles
X_3 = Depth of operation in fathoms (1 Fathom = 6 feet)
X_4 = Actual fishing time in hours
X_5 = Fishing area covered in metres
X_6 = Size of crew in numbers
X_7 = Average experience of crew in years
* Significant at 5% level
** Significant at 1% level
NS = Not significant

The regression co-efficient of depth of operation was positive and significant at p=0.01. The regression co-efficient of actual fishing time in hours was positive and significant at p=0.05. The regression co-efficient of other independent variables were not significant in the estimated function. The regression co-efficient of 1.5192 for X_3 revealed that an increase in the depth of operation by one fathom would result in an increase of the total fish catch by 1.519 kg per fishing trip per respondent. The regression co-efficient of X_4 was 1.2581 showing that the total fish catch could be increased by 1.258 kg with a unit increase in fishing time per fishing trip. The co-efficient of multiple determination (R^2) of the estimated function was found to be 0.8263 implying that 82.63% of the variation in total fish catch per fishing trip was explained by the seven explanatory variables included in the function. Similar production function was estimated for the catamaran category and it was:

$$y_2 = \underset{(3.9952)}{-3.0935} - \underset{(0.0975)}{0.3270 X_1}{}^{**} - \underset{(0.7353)}{1.7819 X_2}{}^{*} + \underset{(0.6337)}{3.0944 X_3}{}^{**} + \underset{(0.5184)}{0.0687 X_4}{}^{NS}$$

$$+ \underset{(0.5078)}{3.5082 X_5}{}^{**} + \underset{(0.6158)}{0.6655 X_6}{}^{NS} + \underset{(0.0582)}{0.2099 X_7}{}^{**}$$

R^2 = 0.8801
F Value = 138.81
n = 150

(Figures in parentheses indicate standard error)

* Significant at 5% level
** Significant at 1% level
NS = Not significant

The partial regression coefficient of fuel consumption was negative and significant at p = 0.01. The depth of operation, fishing area covered in metres and experience of crew was positive and significant at p = 0.01. The regression co-efficient for distance travelled in nautical miles was negative and significant at p=0.05. The regression co-efficient of fuel consumption was – 0.327 indicating that for 1 litre increase in fuel consumption, the total fish catch per fishing trip would decrease by 0.327 kg. It revealed that further increase in fuel use is not advisable / judicious and the need to judiciously use the fuel quantity which would reduce the total cost of fishing. The partial regression co-efficient of –1.7819 for X_2 indicates that an increase of distance travelled by one nautical mile would decrease the total fish landings by 1.78 kg per fishing trip.

The regression co-efficient of 3.0944 for X_3 revealed that the total fish landings would increase by 3.094 kg per trip, if the depth of operation is increased by one fathom. The regression co-efficient of 3.5082 for X_5 indicated that an increase of actual area of fishing covered by gill net operations by one metre would increase the total fish catch per fishing trip by 3.508 kg. The regression co-efficient of 0.2099 for X_7 revealed that an increase of experience of the crew of one year would result in an increase in total fish catch of 0.2099 kg per fishing trip. The co-efficient of multiple determination (R^2) in the estimated function was found to be 0.8801 indicating that 88.01% of the variation in total fish catch per fishing trip per respondent was explained by the seven explanatory variables included in the model.

4. Conclusion

The production function analysis points out the need for taking up fishing technology research projects with specific reference to the aspects such as fishing grounds and depth of fishing operations followed by dissemination of related information to fishermen.

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