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An economic analysis of fishing crafts in Tharuvaikulam fishing village, Tamil Nadu

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Abstract
Marine capture fishing is one of the important sectors in fisheries but at present, this sector face a lot of problems such as the lack of sustainable fishing practices. In this regard, present study deals with gill net, an ecofriendly fishing gear used by three types of fishing craft sectors namely Single Day (SD) Motorised and Multiday (MD) motorised, and MD mechanized for marine capture fishing in the Tharuvaikulam coast. For judicious exploitation of resources and for formulating proper fishery policies, it is imperative to study the comparative economics of types of fishing units engaged in fishing. The efficiency of inputs and the profitability ratio among the three fishing craft sectors were estimated by using appropriate statistical tools in order to find out the effective and economically viable fishing craft methods among these sectors. The present study explains that gillnet fishing by all craft sectors in the study area were sustainable and economically viable method but, while comparing other two sectors, MD motorized sector was more profitable. Encouraging this fishing method will help to maintain sustainable level of fishery resources.

Keywords: gillnet fishing, eco-friendly, comparative economics, profit, sustainable development

1. Introduction
Fisheries sector plays an important role in Indian economy. Marine capture fishing is one of the important sources for nutrition security and livelihood of the people in Tamil Nadu. Tamil Nadu has a coastal length of 1,076 km, 0.91 million sq.km of EEZ and a continental shelf of about 41,412 sq.km. The state ranks 5th in total fish production of the country which was 6.97 lakhs t (from marine resources-4.57 lakhs t and freshwater and brackish water resources -2.40 lakhs t) in the year 2014-15. The export of marine products was 93,477 MT and earned a foreign exchange of Rs.5,308.17 crore during 2014-15 (Rs-Rupees). The fisheries sector of Tamil Nadu has contributed 0.7 percent of the total Gross State Domestic Product (GSDP) of the State (Anon., 2015-2016) [1]. The marine fishery resources are overexploited by the unselective fishing practices (Suuronen, *et al.* 2012) [12] but, in the Tharuvaikulam fishing village in southern coast of Tamil Nadu, where gillnets fishing method has been successfully adopted for a long period by fishermen of three fishing craft sectors namely SD and MD motorized and MD mechanized fishing crafts. Gillnet fishing method is one of the eco-friendly method and fishing gear is selective which will not disturb the bottom resources. It also helps to maintain the sustainable level in marine fishery resources but the efficiency and profitability will vary depending upon the fishing crafts sector. The economic performance of marine fishing operations is influenced by various input factors. Hence, the aim of the study is to compute economic efficiency, profitability of gillnet fishing method and find out the economically viable fishing crafts sector from the study area. In addition, the socio economic profile and fishing details among the fisherfolk is also studied and the cost of and returns for three types fishing crafts sector in present study area is estimated.

2. Materials and methods
Tharuvaikulam fishing village was selected as present study area where sustainable fishing method was successfully practiced for a long period. Tharuvaikulam fishing village is located in the southern part of the Tamil Nadu with an area of 17.28 Km^2 in the geographical plane between 8.8922^o N latitude and 78.1707^o E longitude, about 15 km from Thoothukudi where three types of fishing craft sectors is operated namely Single Day (SD) and Multi Day (MD) motorised and Multi Day (MD) mechanized. Total sample size of the study was 120 which were distributed as 30 for SD motorized, 30 for MD mototrised and 60 for MD mechanized sectors. The above stated samples were selected randomly for data collection in the present study. A survey schedule was designed based on the objectives of the study and it was used for collection of data from the fishermen. The fishermen were contacted individually and the objectives of the study were explained to them before conducting the data collection to ensure their co-operation. Tabular analyses were used to analyze the general characteristics of the fisherman and fishing details. The analysis of the economic performance of fishing methods was assessed by working out the following indicators.

1. Operating cost /year = (Fuel charges + Food expenses + Auction charges + Ice charges + Transport charges + Other's charges).
2. The fixed cost (FC) was calculated as sum of depreciation of craft, gear, and engine, interest on capital cost, insurance and repair and maintenance.
3. The gross revenue is calculated from the species composition of the catch and price per species. The gross revenue is estimated as follows:

$$\text{GR per year} = \sum_{i=1}^{n} \text{qi pi}$$

Where, q_i is the quantity of catch in kg of the i_{th} variety; p_i is the price per kg of fish of the i_{th} variety;

4. Net profit is the profit obtained after deducting operating expenses and fixed cost from the gross income earned per year (Geetha *et al.*, 2014) [6].

2.1 Ratio Analysis

Ratio analysis will help to know the efficiency of the each input such as fixed cost, operating cost and variable cost in marine fishing.

1. Fixed cost ratio is the proportion of fixed expenses in gross income of fishing (Reddy, S. *et al.* 2004) [8].

$$\text{Fixed cost ratio} = \frac{\text{Fixed cost}}{\text{Gross returns}} \times 100$$

2. Gross return ratio is the total cost of the fishing to the gross return (Reddy, S. *et al.* 2004) [8].

$$\text{Gross return ratio} = \frac{\text{Total cost}}{\text{Gross returns}} \times 100$$

3. Operating cost ratio relates variable costs to gross income. The gross income of a craft is the sum total of value by multiplying the quantities of different species/groups with respective price (Aswathy *et al.* 2011) [3].

$$\text{Operating cost ratio} = \frac{\text{Operating cost}}{\text{Gross returns}} \times 100$$

4. Profit margin ratio is a closely related indicator of economic performance, which expresses the net profit as a percentage of the total revenue. A ratio of more than 10% can be considered as good business. (Tietze *et al.* 2005) [13].

$$\text{Profit margin (\%)} = \frac{\text{Net Returns (NI)}}{\text{Total Returns (TR)}} \times 100$$

5. Benefit cost ratio: If the benefit cost ratio is greater than 1 (> 1) the fishing is profitable and if it is exactly 1, it means the fishing is at breakeven, i.e., neither making profit nor loss. When the ratio is less than 1 (< 1), the project is operating at a loss.

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Total Returns (TR)}}{\text{Total Cost (TC)}}$$

3. Result and Discussion

The results from the analysis of the data gathered from the fishermen at Tharuvaikulam fishing village, Thoothukudi and inferences drawn are represented and discussed as follows.

3.1. Key factors in marine fishing

The distance of the fishing ground is a vital factor influencing the economics of operation of a fishing vessel. In the study area, the average distance of fishing operation for SD motorized sector was 30 miles from the shore area (table 1). Similarly, the fishing distance for MD motorized and MD mechanized sectors were upto 60 miles along the shore area.

Table 1: Fishing details

Factors	Motorized crafts		Mechanized crafts
	SD fishing	MD fishing	MD fishing
Size of crew (no.)	4	7	10
Crew share (ratio)	--	50:50	50:50
Average no. of fishing trip (no./month)	15-20	3-4	3-4
Time to reach the fishing ground (hrs)	2 -3	6-8	8-10
Distance of fishing ground (miles)	10	60	60
Type of gears used	Crab net, Squid hook line	Gill net, *Mural net*	Gill net, *Mural net*

The average crew strength for SD motorized was 4, for MD motorized and ranged from 6 to 8 and 8 to 10 in the case of MD mechanized sectors. The SD motorized sector usually had daily fishing operation. MD motorized and MD mechanized sectors normally had multiday fishing operations and the number of fishing days per trip varied from 6 to 10 in marine fishing in the study area.

The gears like *mural valai* and *paru valai* were largely used by MD motorized and MD mechanized sectors. *Nandu valai*, *kanava thondil* and *mural valai* were used by SD motorized sector in marine fishing.

In the study area, crew share ratio was 50:50 which means 50% for owner and 50% for labour from the catch value after covering the operating cost.

The fishing trips per month for SD motorized varied from 15 to 20 and for MD motorised and MD mechanized sectors, it was 3 to 4 due to variation of fishing days.

3.2. Socioeconomic characteristics of fishermen

In fisheries sector, socio economic status of fisherfolk plays a key role in fish production activities. Predominant age group of the selected fishermen was middle age representing 76.6 % of the total fishermen of SD motorized sector. Similarly, the predominant age group of MD motorized and MD mechanized sectors fishermen respondents were middle age (43.2 %) and young age group (63.2 %), respectively. This finding was in line with the findings of Sujathkumar (2000) [11], Tyagi *et al.* (2007) [14] and Sarma and Bose (2008) [9].

Almost 63.3 % of the respondents had fishing experience more than 15 years in the case of SD motorized sector. Similarly about 73.3 % and 66.6% of the selected respondents representing MD motorized and MD mechanized sectors had experience more than 15 years, respectively. This observation was in line with the conclusion of Kiron (1992) [7], Sujathkumar (2000) [11] and Aruloli (2004) [2] who reported

that most of the fishermen had more than 10 years of experience in fishing.

About 63.3 % of the respondents had primary level education in the case of SD motorized sector but, in the case of MD motorized and MD mechanized sectors, about 66.6 % of the fishermen had primary level of school education. This finding aligned with that of Deepthi Ande, (2011) [5]. It showed that most of the respondents had primary level education due to easy accessibility to primary school in the study area. It was also noticed that 73.3% of SD motorized sector fishermen had large family, 50% of MD motorized sector fishermen were found to have medium sized family. Similarly, 53.3% of respondents had large size family in MD mechanized sector.

3.3. Economic analysis of marine capture fishing

The study analysed the viability of various fishing units of Tharuvaikulam fishing village using different economic and financial indicators.

The capital investment of a fishing unit varied with size of craft, type of engine and the numbers and pieces of gear owned. These factors influenced the economic efficiency of the fishing craft sectors. Most of the fishing units in operation were old. There was a considerable cost difference in the initial investment of old and new units. The capital investment details of different fishing craft categories are shown in Table 2.

Table 2: Estimation of capital cost (Rs in lakhs)

Items	Motorized crafts		Mechanized crafts	Overall
	SD fishing	MD fishing	MD fishing	
Craft Original cost	2.70±1.59	5.56±4.25	16.18±0.94	20.31±11.62
	0.50-7.00	2.00-15.00	7.00-50.00	2.00-51.00
	58.8	76.5	58.4	57.2
Present worth	1.25 ±0.77	3.05±2.84	8.61±6.82	10.76±8.21
	0.20-3.00	0.10-11.00	0.50-30.00	0.60-35.70
	61.7	93.3	79.2	76.3
Gear Original cost	0.77±0.53	3.06±2.51	9.18±5.36	11.09±5.98
	0.35-2.40	0.30-10.00	1.00-20.00	1.00-32.90
	69.1	82.3	58.2	53.3
Present worth	0.14±0.13	1.03±1.40	1.72±9.68	2.31±0.25
	0.30-0.50	0.01-5.00	0.52-5.00	0.25-8.20
	72.2	81.3	56.1	63.4
Engine Original cost	1.01±0.39	1.00±0.32	0.53±0.42	2.65±1.09
	0.50-2.50	0.10-3.00	0.10-2.00	1.09-1.30
	38.2	91.3	80.4	41.5
Present worth	0.17±0.12	0.42±0.59	0.07±0.12	0.69±0.63
	0.07-0.80	0.05-2.00	0.07-0.50	0.12-0.50
	71.8	82.3	63.2	91.3

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

The overall mean original cost (OC) of crafts was estimated at Rs 20.31 lakhs with the coefficient of variance of (C.V) 57.2 % (table 2). The overall mean present worth (PW) for fishing crafts was estimated at Rs 10.75 lakhs with co-efficient of variance of 76.3%. It was found that average original cost and present worth of craft was higher for MD mechanized sector (OC: mean- 16.18, C.V- 58.4; PW: mean- 8.61, C.V-79.2). The overall mean cost for fishing gears was computed as Rs 11.09 lakhs with co-efficient of variance of 53.3 %. The overall mean present worth of fishing gears was estimated at Rs 2.31 lakhs with co-efficient of variance of 63.4%. It explained that the average original cost and present worth of fishing gear for mechanized sector viz., OC: mean- 9.18, C.V-58.2 %; PW: mean-1.72, C.V-56.1 %. When comparing three fishing sectors, high investment of craft and gear for mechanized sector due to modern technology and high fish holding capacity. The overall mean original cost of engine used by fishing craft was estimated at Rs 2.65 lakhs with C.V of 41.5%. The overall mean present worth for engine worked out as Rs 0.69 lakhs with co-efficient of variance of 91.3%. It showed that the average original cost and present worth of engine was higher for MD motorized sector (OC: mean- 1.01, C.V-38.2%; mean-0.42, C.V-82.3%) due to replacement with advanced engine for marine fishing.

Depreciation of the fishing unit, interest for capital cost, repairs and maintenance and insurance per year constitute the fixed cost. Depreciation was worked out on the basis of the expected life of the fishing boat and accessories and interest was calculated at the rate of 7.50% per annum. The fixed cost details of different fishing craft categories are shown in Table 3.

Table 3: Estimation of fixed cost (in Rs / year)

Items	Motorized crafts		Mechanized crafts	Overall
	SD fishing	MD fishing	MD fishing	
Depreciation of fishing craft	41922±23295	60575±38821	179625±270907	231883±272791
	10000-100000	18000-166666	50000-1466667	10000-1466667
	55.1	64.4	62.3	68.8
Depreciation of fishing gear	82519±71767	156116±122971	398180±334011	521476±363730
	20000-320000	14500-500000	60000-1500000	20000-1600000
	86.5	78.1	83.2	69.2
Depreciation of engine	12753±11373	19733±14451	21886±8591	38955±22621
	1571-45000	1250-59000	2500-55000	8600-111500
	89.1	73.2	39.5	58.2
Interest on capital cost	58287±23042	119019±70274	342946±137940	431600±184177
	14300-126100	25350-253500	85800-702000	153400-908700
	39.7	59	40.3	42
Repairs and maintenance cost	7296±3138	143833±51580	195600±425842	245281±325456
	2000-13000	36000-200000	100000-300000	100000-612500
	43.4	58.2	36.5	62
Insurance	343±510	433±568	1625±631	2013±1043
	0-2000	0-2000	1000-3200	1000-6000
	76.1	78.9	38.6	51.3

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

The day to day expenses incurred for the operation of the boat is termed as operating expenses or variable costs. The expenses on fuel, wages, food, ice, transport and auctioning of fishes were the major components of variable cost. The variable cost for marine fishing is given in Table 4.

Table 4: Estimation of variable cost (lakhs / year)

Items	Motorized crafts		Mechanized crafts	Overall
	SD fishing	MD fishing	MD fishing	
Fuel cost	3.57±1.34	4.84±1.54	5.67±1.44	9.89±5.13
	2.01-6.00	2.03-7.95	3.08-8.82	3.30-18.15
	37.1	31.0	25.3	51.3
Food expenses	Nil	1.46±0.45	2.91±3.58	3.64±3.5
		0.72-2.40	0.63-29.40	0.94-29.40
		30.0	98.2	97.2
Ice cost	Nil	0.70±0.34	1.29±0.44	1.64±0.60
		0.36-1.44	0.52-2.62	0.63-3.54
		48.1	34.3	36.3
Transport cost	Nil	2.05±1.11	4.36±7.12	5.39±7.07
		0.48-4.80	0.63-5.25	1.26-5.25
		54.4	58.0	63.0
Auction charge	1.89±0.44	6.87±2.22	9.07±2.24	14.35±6.63
	1.10-2.95	5.01-12.58	4.49-15.65	5.01-24.30
	23.0	25.0	24.0	46.7
Other expenditure	0.77±0.45	0.22±0.09	0.41±0.17	0.91±0.65
	0.24-1.56	0.10-0.48	0.12-1.05	0.18-2.44
	58.0	40.0	43.0	72.0

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

The overall mean of total cost of marine fishing in study area was estimated at Rs 41.17 of which total variable cost and total fixed cost accounted for Rs 29.22 and Rs 14.57 lakhs, respectively.

In the case of SD motorized sector, mean total variable cost (Rs 5.53 lakhs) and total fixed cost (Rs 1.94 lakhs) constituted total cost of Rs 7.47 lakhs (table 3&4). Fuel cost (57%) and auction charge (30%) took the major share among the variable items (fig 4). Among the fixed cost, depreciation of fishing gear (30%) and interest on capital cost (27%) were the major items (fig 1). The mean total returns and net returns were Rs 17.18 lakhs and Rs 7.27 lakhs, respectively (table 5).

Table 5: Estimation of total cost (Rs in lakh /year)

Items	Motorized crafts		Mechanized crafts	Overall
	SD fishing	MD fishing	MD fishing	
Total fixed cost	1.94±0.99	5.44±4.97	10.87±5.02	14.57±6.91
	0.05-4.80	1.34-29.53	2.87-27.93	2.87-36.65
	51	91	46	47
Total variable cost	5.53±1.33	5.63±4.97	23.74±9.70	29.22±11.67
	3.59-8.48	1.34-29.53	0.99-75.77	13.70-75.77
	24	91	40	39.3
Total cost	7.47±1.78	10.88±9.94	34.62±10.75	41.17±12.96
	4.87-11.61	1.09-59.07	20.96-85.23	20.96-85.23
	23	10	31	31
Total returns (excluding crew wage)	17.18±4.05	15.37±22.09	89.06±24.49	140.34±68.02
	9.90-26.58	45.14-127.49	11.19-156.58	11.19-271.93
	23	25	27	48.2
Net returns	7.27±5.39	39.77±11.92	28.05±10.20	51.58±31.10
	2.99-19.02	12.55-61.70	9.98-60.46	9.98-112.20
	74	29	36	60

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

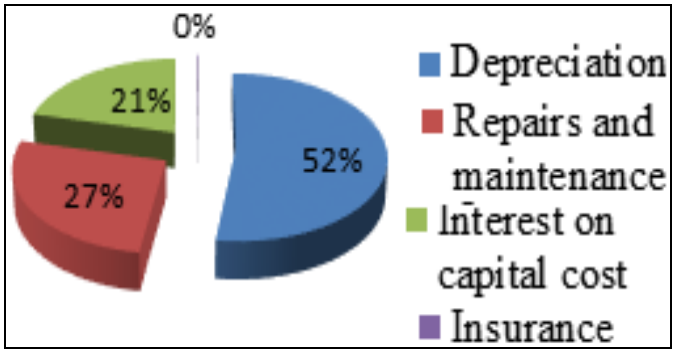

Fig 1: Distribution of fixed cost for SD motorised sector

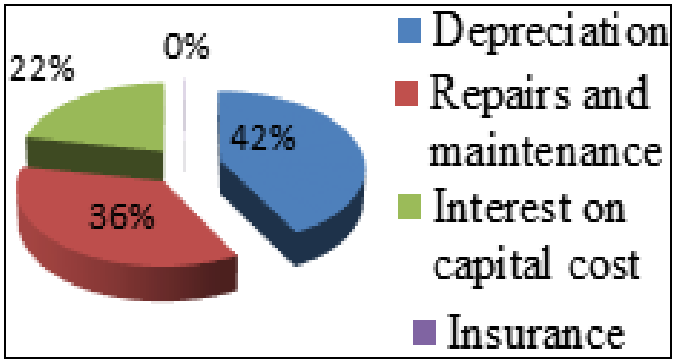

Fig 2: Distribution of fixed cost for MD motorised sector

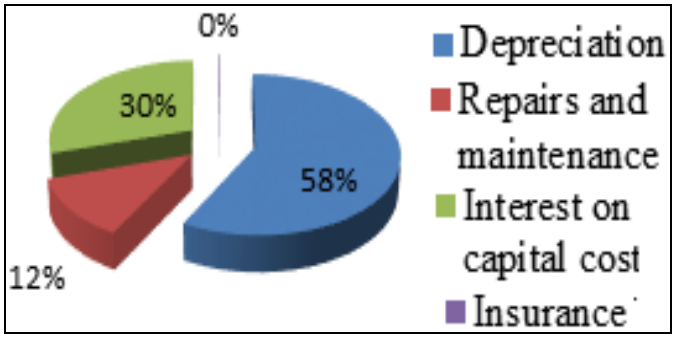

Fig 3: Distribution of fixed cost for MD mechanised sector

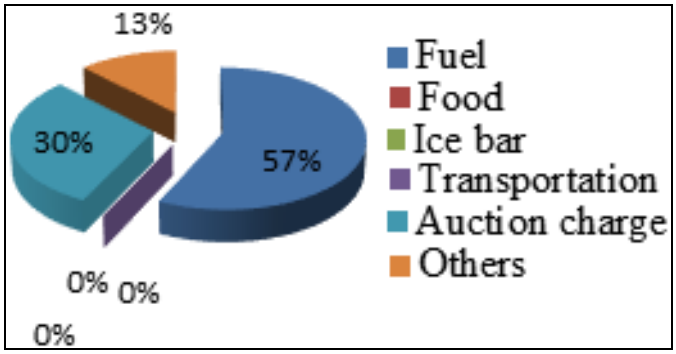

Fig 4: Variable cost for SD motorised sector

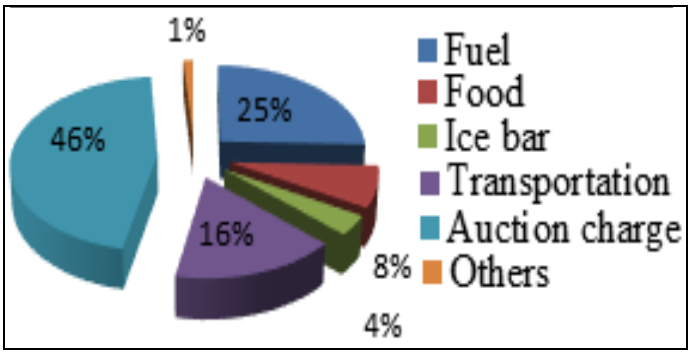

Fig 5: Variable cost for MD motorised sector

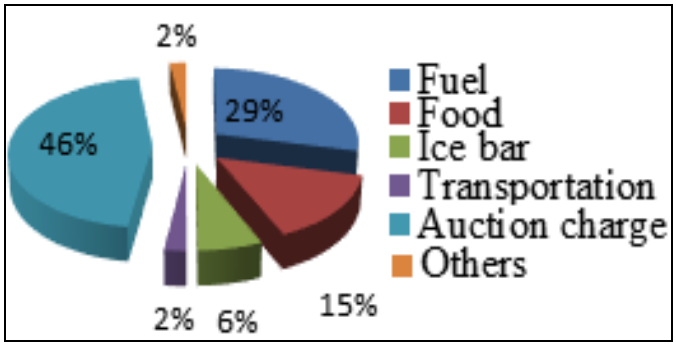

Fig 6: Variable cost for MD mechanised sector

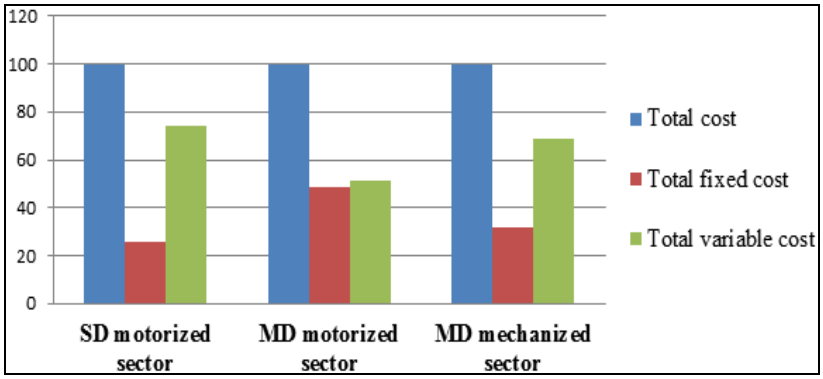

Fig 7: Total cost for craft sectors

For MD motorized sector the mean total cost was computed as Rs 10.88 lakhs of which total variable cost and total fixed cost accounted for Rs 5.44 lakhs and Rs 5.44 lakhs, respectively. Among the variable cost items auction charge paid 46% and fuel 25% were the major components. Geetha *et al.* (2014) [6] stated that the average operating cost per kg of fish of the MD gillnetter was worked out to Rs 36.7 lakhs. In the same line, present study revealed that highest annual average total variable cost was observed for MD mechanized (gillnetter) sector. Senthiladeban *et al.* (2015) [10] recorded that the mean total variable cost was calculated as Rs 2,11,161 per year for *vallam* category. Among the fixed cost items, depreciation of gear 36% and interest on capital cost formed the major share 29 % while insurance had no share. The average total returns and net returns were Rs 15.37 lakhs and Rs 39.77 lakhs, respectively.

In mechanized sector, the mean total variable cost of Rs 23.74 lakhs and total fixed cost of Rs 10.87 lakhs constituted to Rs 34.61 lakhs as total cost. Auction charge (46%) and fuel cost (29%) took the major share among the variable cost items (fig 7). Among the fixed cost items, depreciation of fishing gear (34%) and interest on capital cost (30%) were the major ones. The average total returns and net returns were calculated as Rs 89.06 lakhs and Rs 28.05 lakhs, respectively.

3.4. Ratio analysis

Ratio analyses provide information to decide on whether the existing cost of marine fishing are higher or lower. These ratios indicated that proportion of gross benefit is used to meet different types of expenditures in fishing (Reddy, S. *et al.* 2004) [8].

Table 6: Ratio analysis in marine fishing

Ratios	SD motorised sector	MD motorised sector	MD mechanized sector
Operating cost ratio (%)	32.1	24.2	26.1
Fixed cost ratio (%)	11.3	6.9	11.9
Productivity ratio (%)	43.4	31.2	38.1
Profit margin (%)	42.3	46.5	50.0
Benefit Cost Ratio (BCR)	2.29	2.72	2.63

The operating cost ratio for SD motorised, MD motorised and MD mechanized sectors were worked out as 32.1%, 24.2% and 26.1%, respectively, indicated that the operating cost ratio was higher for SD motorised sector when compared to other sectors due to low variable cost (table 6). The results of Geetha *et al.* (2014) [6] revealed that 70% of the gross income was spent towards operating expenses by MD gillnetter. Similarly, Datta, K.K and Dan (1992) reported that in the mechanized sector (Gillnetter) operating cost ratio was calculated as 39% to the gross income.

Fixed cost ratio gave the proportion of fixed expenses to the gross benefits of fishing operation. The ratio for SD motorised, MD motorised and MD mechanisd sectors was worked out as 11.3%, 6.9% and 11.9%, respectively. Geetha *et al.* (2014) [6] stated that for every one rupee earnings 2.6% was shared by fixed expenses of the gillnetter. Aswathy *et al.* (2011) [3] revealed that the financial analysis showed better performance with a higher return on investment (167%) for SD gillnetters.

The financial performance was measured by profitability of marine fishing. A level of 10% was generally considered to be a good result. The net profit expressed as a percentage of the invested capital, indicated the profitability of the investment in relation to other alternative investments (Tietze *et al.* 2005) [13]. In the present study, profitability of SD motorised, MD motorised and MD mechanized sectors was worked out as 43.4%, 31.2% and 38.1%, respectively. Geetha *et al.* (2014) [6] estimated 73.6% as profit margin ratio for gillnetter. SD motorised and MD mechanized have high fixed cost efficiency among the three fishing sectors. Productivity efficiency ratio is very high for SD motorised sector due to low investment cost. Profit margin and benefit cost ratio is high for the MD motorised sector due to high quantity of fish catch and total cost efficiency.

If BCR was greater than 1, the project is profitable. BCR for SD motorised, MD motorised and MD mechanized sectors were estimated at 2.29, 2.72 and 2.63, respectively. It was found that all the three sectors in the study area adopted gillnet fishing method with profitability. MD gillnetters were found to be more efficient as indicated by different criteria of

economic viability and gill net fishing leads to sustainable fishing when compared to trawlers (Geetha *et al.* 2014) [6].

The present study suggested that SD motorised, MD motorised and MD mechanized sectors (gillnetter) are economically and financially viable and generate sufficient revenue to cover the cost of depreciation, interest on capital cost and thus generate sufficient funds for reinvestment. Aswathy *et al.* (2011) [3] also reported the same.

4. Conclusion

The present study showed that middle age group of fishermen was found in SD and MD motorized sectors and young age groups were mostly in MD mechanized sector. Among the three sectors, most of the fishermen had more than 15 years of experience in marine fishing and majority of the respondents had primary school education. The family size of the fishermen was large (above 5) for the selected three sectors. While SD and MD motorized sectors of fishermen earned low and medium income, MD mechanized sector respondents earned high income. For the three fishing sectors, depreciation of fishing gear and interest on capital cost were found to be the major items in the estimation of total fixed cost. Auction charge and fuel cost are the major costs in accounting the total variable cost among the three fishing craft sectors. Total variable cost contributed more in the total cost of all the three fishing sectors. MD motorized fishing sector had higher net returns in marine fishing due to less operational cost with higher returns. Hence this study explains that gillnet fishing by all craft sectors in the study area was sustainable and economically viable fishing method but when comparing other two sectors, MD motorized sector was more profitable. Encouraging this fishing method will help to maintain sustainable level of fishery resources.

It could be recommended from the study that conversion of trawler to gillnetter in marine fishing as MD motorised and MD mechanised sectors is preferable because these craft sectors would be profitable and environment friendly, thereby not causing much damages to bottom marine fishery resources.

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