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Economic evaluation of marine fishing operations in Purba Medinipur district of West Bengal, India

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Original Article

Abstract

The marine fish landing in West Bengal, India during 2020 was estimated at 2.60 lakh tonnes, contributing 9.5% of the total marine fish landings in the country. The techno-economic evaluation of different fishing methods on the West Bengal coast was carried out to assess the economic efficiency. The boat and net combinations throughout the years have seen spectacular changes because of the enormous expense of fishing, the time taken for fishing and the pre-funding of activities and support. Fuel accounted for the major share (56 to 66%) in operational costs of mechanized crafts. In motorized crafts, the contribution of fuel to operational costs ranged from 21.6% to 23.6%. Crew wages, which formed only 17.8 to 23.2% of the operational costs in mechanized crafts, contributed the major share (44.4% to 54.7%) in motorized crafts. In non-motorized crafts, more than 70% of the operational cost was towards crew wages. Net Profit Margin and Return on Investment were 16.2 to 22.9% and 0.5 to 1.07 for mechanized fishing operations, 21.1% to 59.3% and 0.42 to 1.85 for motorized fishing operations and 26.3% to 31% and 1.25 to 3.92 for non-motorized fishing operations, indicating motorized fishing operations to be the most economically efficient method. Capital Productivity and Input-Output Ratios were 0.65 to 0.85 and 0.47 to 0.65 for mechanized fishing operations, 0.38 to 0.70 and 0.13 to 0.23 for motorized fishing operations and 0.65 to 0.67 and close to nil for non-motorized fishing operations. The gross value added (GVA) of all fishing operations worked out to about 50 % of the gross revenue, which is a significant contribution to the economy. In fishing tasks, the expanded expense of fishing per trip, the diminished landings and the ensuing decrease in the gross returns per trip have been cited as significant requirements influencing the financial returns from various fishing methods, by the fishers.

Keywords: *Costs, returns, capital productivity, labour productivity, input-output ratio, gross value added*

Introduction

Marine capture fisheries serve as significant sources of employment, income and foreign exchange earnings besides providing nutritional security to the populace. The paradigm has changed from subsistence fishing to the position of a multi-billion industry due to dynamic technological changes in both harvesting and post-harvesting methods. To achieve the objectives of the United Nations Sustainable Development Goals (SDG 14), fishing operations must become environmentally sustainable, socially acceptable and economically viable. Though, there are a plethora of studies available on the environmental aspects of fisheries, information on social and economic aspects is only available in isolated patches and regions. This when used for national computations often leads to erroneous estimates. Besides, a lot of structural changes have taken place in the socio-techno-economic aspects of fishing, which has far-reaching implications for the performance of the sector (Raju *et al.,* 2022a).

West Bengal, the northernmost maritime state of the east coast of India, lies between 21° 25′ to 27° 13′ North latitude and 85° 50′ to 89° 50′ East longitude. The continental shelf up to 200m depth covers an area of about 20,000 km^2, which is 3.6% of the total area of the Indian continental shelf. There are two coastal districts in West Bengal, *i.e.* (1) South 24-Parganas and (2) Purba Medinipur contributing to the organized marine capture fisheries of the state. With a coastline of 158 km (about 1.9% of the total coastline of India), 49 marine fish landing centres (3.9% of total marine fish landing centres of India), West Bengal gives sustenance to about 81,067 fishermen families comprising

3.69 lakh fisher folks (9.5% of the total fisher folk population of India) residing in 171 marine fishing villages (5.7% of the total marine fishing villages of India) (CMFRI-FSI-DoF, 2020). Most of the fisher folk (about 70%) are traditional fishermen (CMFRI-FSI-DoF, 2020). A major chunk (about 55,301 families) of the fisher population is socio-economically vulnerable as they are below the poverty level and about 81% of the fishers' houses are Kutcha houses and 19% are Pucca houses (CMFRI-FSI-DoF, 2020).

Despite COVID-19 lockdowns and the devastating Amphan cyclone (Raju *et al.,* 2020), West Bengal has recorded a mild increase of 5% in its marine fish landings during 2020. The state recorded 2.60 lakh tonnes of total landings contributing 9.5% of the total marine fish landings in the country, while in 2019, the landing was 2.49 lakh tonnes (CMFRI, 2022). The coastal districts; South 24 Parganas and Purba Midnapur contributed nearly equal shares with 49% and 51% to the total landings, respectively. The composition of the fish landed in West Bengal included pelagic (49%), demersal (32%), crustacean (16%) and molluscan (3%) resources, respectively. About 4,014 mechanized crafts and 6,564 motorized and 476 non-motorized crafts are engaged in marine fishing activities in the state. The mechanized and motorized sectors contributed 89.7% and 10.1% of the total landings respectively, while the non-motorized sector contributed only 0.2%. A major share of the total marine fish landings in the state was attributed to the mechanized sector (CMFRI, 2022). Though gill netters are the dominant fishing craft (33% of the total fishing crafts in the state), a major portion of the marine resources (about 60%) are exploited by trawlers in West Bengal. The estimate of the value (Rupees crores) of marine fish landings in 2020 at Point of First Sales and Point of Last Sales was 4148 and 5822 respectively. The unit price per kg of fish at the landing centre was ₹159.54 and at retail was ₹223.92 (CMFRI, 2022).

The craft and gear combination in West Bengal had undergone dramatic changes in the past decade under the enormous expense of fishing, the span and profundity of tasks and the drastic decline in the availability of marine fishery resources. For assessing the economic efficiency and for ensuring judicious exploitation of resources in formulating pertinent and appropriate fishery policies, it is basic to contemplate the relative financial aspects of different kinds of fishing methods and gears operated in West Bengal. However, apart from a few studies on the techno-economic efficiency of resource use in the trawl fishery by Narayanakumar and Sathiadhas (2005) and Bose and Sharma (2010) a decade back and in the motorized and traditional fishery by Raju *et al.* (2017), studies are lacking till date. The most important aspect, *viz.*, economic performance/efficiency of different fishing methods, which rules the multimillion fishing industry of the state, has been ignored, and it is of no surprise, that the marine fishing industry of the state is in collapse (Ghosh *et al.*, 2015). It is in this setting that the current investigation on comparing the monetary effectiveness of various crafts and gears in West Bengal assumes paramount importance. The paper investigates the suitability of different fishing boat-nets blends and utilizes diverse monetary and budgetary markers for effective fisheries governance. The economic analysis of marine fishing in the present manuscript will give crucial data to outlining suitable approaches for the fair and feasible improvement of the marine fisheries in West Bengal, and when replicated for other maritime states, can lead to the development of a national policy document on techno-economic performance of fishing fleets, which can then be the guiding principles in rejuvenating our marine fishery.

Material and methods

In the present study, the Purba Medinipur district was selected, since factors like the number of fishing villages, landing centres, fisher population, fishing activities and marine fish production were comparatively higher than another coastal district (Souh-24-Parganas) in West Bengal (CMFRI-DoF, 2020). The information on investment, operational expenses and returns of different boats-net blends were gathered from 10 fishing units per month in every fishing method (Mechanized, motorized, and non-motorized) working at Digha Mohana, Dadanpatrabar, Sankarpur, New Jaldha and New Digha landing centres of Purba Medinipur district (Fig. 1). Data on the investment details were collected as one-time data collection. The costs and returns data were gathered for each month from ten sample units of mechanized, motorized, and non-motorized fishing methods from July 2021 to March 2022. Thus, the sample size was 270 units. Information on

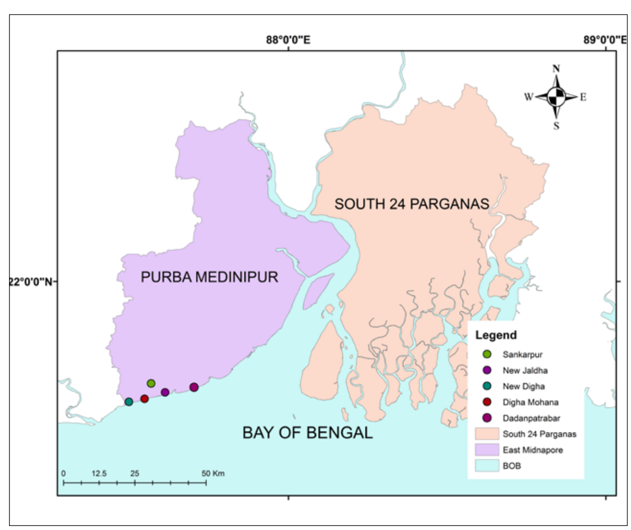

Fig. 1. Map of the study area in West Bengal

the amount and estimation of various species caught by the units; labour share costs and wages including food, stores and other provisions; fuel (energy) expenses; expenses on craft and gear repair and maintenance and other operational costs; expenses of different inputs; auction charges, berthing charges and taxes; capital costs involving investment of fishing crafts and gears; information on boats and nets and personnel details were gathered from the random sampling method using a pre-tested schedule.

Both primary and secondary information were gathered for the investigation. The secondary information relating to the fishing boats and nets, marine fish yield throughout the years by various areas and socio-economic conditions were gathered from different reports of ICAR-Central Marine Fisheries Research Institute and factual reports of the Government of West Bengal.

The investigation of the monetary exhibition of fishing techniques was evaluated by working out the working expense per trip, gross income per excursion and net income per trip through tabular examination. The capital and labour profitability were likewise worked out utilizing working proportion and catch per person per trip, individually to survey the monetary exhibition (Sathiadhas, 1989). By and large, working proportion, net income, capital profitability, labour efficiency (kg/person/trip), input-output proportions, Gross Value Added and Gross Value Added as a per cent of Gross Revenue (Narayanakumar *et al.*, 2009; Raju *et al.*, 2022a, 2022b) were worked out as the pointers of financial proficiency of various fishing units.

Cost-return proportions were utilized to quantify the overall input and output efficiency in terms of value. Working cost proportion relates variable expenses to gross revenue. The income or the gross revenue of a unit is the whole of total worth by multiplying the amounts of various species/groups with their respective prices.

Input-Output proportion = Input expenses/Total Revenue…...(1)
Working proportion = Operating expenses/Total Revenue..(2)

The essential information was gathered on working expenses per trip, which incorporated the expenses of fuel, labour compensation, food costs, sell-off charges, fix and upkeep and other everyday costs for completing the fishing tasks. The working expense per trip was in this manner determined as follows.

Working cost/trip = (fuel + labour charges + food costs + sell-off charges + fix and upkeep charges + other expenses) ....(3)

The gross income per trip was determined from the species composition of catch and value per species. The gross income per trip was assessed as follows.

$$\text{GR per trip} = \sum_{i=1}^{n} q_i p_i \quad (4)$$

Where,

q_i is the amount of catch in kg of the i^{th} assortment
p_i is the value per kg of fish of the i^{th} assortment

Labour efficiency = Catch (kg)/Number of Crew…….............. (5)
Net Cash Flow (NCF) = Gross Revenue – Operational Costs …. (6)

The net cash flow is regarded as an award for entrepreneurship.

Gross Profit = Net Cash Flow – Depreciation……... (7)
Net Profit Before Taxes (NPBT) = Gross Profit – Interest…. (8)

Net Profit Margin = NPBT / Revenue from landings……. (9)

The net benefit margin is a proportion of benefit after the sum of what expenses have been represented and mirrors the level of income that a vessel proprietor holds as a benefit.

Return on Investment (ROI) = NPBT / Value of assets…(10)
Gross Value Added (GVA) = Net Cash Flow + Labour costs...(11)

The gross worth added shows the arrival of the fishing vessel tasks to the economy and is useful for making future fisheries sector investment and expenditure decisions.

GVA to revenue = GVA / Gross revenue from landings…….. (12)

The GVA to revenue figure is expressed as a percentage and provides for the portion of income that adds to the economy through the creation factors (Carvalho *et al.*, 2020).

Results and discussion

A review of the financial aspects of various kinds of fishing units showed that practically all sorts of fishing units, on a normal, run-on benefit as their creation outperforms the breakeven point (Sathiadhas, 1989; Narayanakumar *et al.,* 2009). Despite the expansion in crafts and the reduction in the catch rates, the fishing sector can sustain itself mostly because of the expansion in the price of nearly, all the types of fish. Be that as it may, attributable open-access nature of marine capture fisheries and the intense competition for resources associated with it, many of the less efficient fishing units are as a rule gradually eliminated from activity because of the misfortunes. Hence, the relative financial effectiveness of various craft-gear combinations using different key monetary markers was assessed based on costs and returns data.

Fishing operations

Mechanized Fishing Crafts: Trawlers and gill netters, with an average overall length (OAL) of 51-54 feet and powered by engines with capacities of 140-338 H.P are the principal crafts under this category and perform, mostly multi-day fishing operations ranging from 7 to 9 days. Trawlers and gill netters land mostly, *Sardinella fimbriata, Rastrelliger kanagurta, Hilsa kelee, Pampus griseus, Tenualosa ilisha* and *Parapenaeopsis hardwickii, etc.*

Motorized Fishing Crafts: The motorized crafts, mostly operating gill net and bag net perform single-day fishing operations and are of an average of 26-33 feet OAL with engine power ranging from 23-24 H.P. *Harpadon nehereus, Setipina tenuispinis, Acetes* spp., *Plicofollis layardi* and *Sillaginopsis panijus* are chiefly caught by bag net. Catfishes, snappers, eels and seer fishes are caught chiefly in hook and line. The gill net land is mostly *Tenualosa ilisha, Harpadon nehereus, Lepturacanthus savala, Rastrelliger kanagurta, Pterotolithus maculatus* and *Coilia dussumierii.*

Non-motorized Fishing Crafts: The traditional/non-motorised crafts, operating gill net and shore seine have an average OAL of 18-21 feet. Shore seine land mostly *Stolephorus* spp., *Eleutheronema tetradactylum, Pomadasys maculatus* and *Hilsa kelee, etc.* The catch in the gill net is comprised chiefly of *Eleutheronema tetradactylum, Escualosa thoracata, Deveximentum insidator, Harpadon nehereus* and *Johnius* spp. *etc.*

The details of fishing operations by mechanized, motorized and non-motorized crafts are presented in Table 1.

Economic Performance

The analysis of the resource use in marine fishing methods indicated that fuel accounted for the major share (56 to 66%) in operational costs of mechanized crafts as they undertake multiday fishing voyages, go to distant fishing grounds and use active fishing methods. Similar observations were made by Bose and Sharma (2010) in Andhra Pradesh. In motorized crafts, the share of fuel in the total operational cost ranged from 21.6% in the case of bag net to 23.6% in Gill net. However, higher contribution by fuel to operational costs in motorized crafts, ranging from 35% to 42% was earlier reported during 2003-2004 by Raju *et al.* (2017). On the contrary, crew wages which formed only 18 to 23% of the operational costs in mechanized crafts, contributed the major share, ranging from 44.37% (Bag net) to 54.68% (Gill net). Similar reports on labour costs to be significantly higher in motorized crafts were reported from Kerala by Balan *et al.* (1989). In non-motorized crafts, almost the entire operational costs were towards crew wages. There was no expense towards fuel as non-motorized crafts are driven by the power of wind using sails.

The average total value of assets (including craft, engine, propeller, gear, rope and all other accessories required to perform fishing) was ₹58 lakh for a mechanized unit, whereas for the motorized unit, it was ₹4.36 lakh and for non-motorized unit it was ₹0.75 lakh. Annual depreciation of mechanized crafts was high (₹6,82,400), whereas, for motorized (₹1,14,625) and non-motorized crafts (₹35,600), it was very low. The depreciation was calculated taking into consideration the purchase value of the craft and the economic life of the craft. Similarly, the annual interest on fixed capital assets was high (₹4,07,855) for mechanized crafts and very low for motorized (₹30,570) and non-motorized (₹5,250) crafts.

The marine fisheries of West Bengal exhibited seasonal variations to a great extent and the quantity-wise and valuation-wise landings of major species in mechanized fishing, motorized fishing and non-motorized fishing in the year 2021-22 are given in Tables 2, 3 and 4.

The economic performance of mechanized, motorized and non-motorized fishing operations is presented in Tables 5, 6 and 7. It is seen from the tables that the net profit margin was

Table 1. Technical profile of fishing equipment and fishing pattern in Purba Medinipur district of West Bengal

	Mechanized (MDF) n= 90		Motorized (SDF) n=90		Non-motorized (SDF) n=90	
Particulars	Gill net	Trawl net	Gill net	Bag net	Gill net	Shore Seine
Overall Length (OAL) (feet)	51	54	33	26	21	18
Engine (HP)	140	338	24	23	-	-
Number of Crew	13	13	7	6	3	3
Depth of Fishing (m)	20.4	32	10	12.6	5.2	4
Distance to fishing ground (km)	41.3	69	10	8.4	3	0.47
Number of hauls/trip	2	7	1	9	1	1
Duration of haul (h)	2.59	2.24	2	5.35	1.75	2

highest (22.1% to 59.3%) for motorized fishing operations, followed by non-motorized fishing operations (26.3% to 31%) and the lowest (16.2 to 22.9%) in mechanized fishing operations. A Net Profit Margin higher than 20% is considered to be good with higher operating efficiency. This indicated motorized fishing operations to be the most profitable and mechanized fishing operations to be the least profitable. Similarly, Sathiadas (1989) when comparing the financial efficiency of sailcrafts working various fishing nets in Tamil Nadu concluded that non-motorized sailboats operating

Table 2. Species-wise composition in Mechanized fishing of Purba Medinipur district of West Bengal (%) (*n*= 90)

Species	Quantity share	Species	Value share
Sardinella fimbriata	19.59	*Rastrelliger kanagurta*	11.26
Rastrelliger kanagurta	11.74	*Pampus griseus*	8.79
Megalaspis cordyla	10.64	*Hilsa kelee*	6.70
Hilsa kelee	7.22	*Tenualosa ilisha*	5.61
Harpadon nehereus	3.99	*Penaeus monodon*	5.50
Portunus sanguinolentus	2.42	*Sardinella fimbriata*	4.74
Cynoglossus arel	2.42	*Megalaspis cordyla*	3.90
Parapenaeopsis hardwickii	2.29	*Eleutheronema tetradactylum*	3.71
Cynoglossus spp.	2.15	*Parapenaeopsis hardwickii*	3.36
Johnius spp.	2.09	*Parastromateus niger*	3.05
Trichiurus lepturus	2.01	*Trichiurus lepturus*	2.66
Coilia dussumieri	1.74	*Portunus sanguinolentus*	2.14
Thryssa spp.	1.69	Cuttlefish	2.12
Lepturacanthus savala	1.55	*Cynoglossus arel*	2.11
Cuttlefish	1.54	*Pterotolithus maculates*	1.97
Pampus griseus	1.47	*Cynoglossus* sp.	1.85
Coilia ramcarati	1.46	*Pampus chinensis*	1.85
Chirocentrus dorab	1.40	*Plicofollis dussumieri*	1.71
Pterotolithus maculatus	1.40	*Chrysochir aureus*	1.60
Solenocera crassicornis	1.34	*Chirocentrus dorab*	1.53
Others	19.84	Others	23.84

Table 3. Species-wise composition in Motorized fishing of Purba Medinipur district of West Bengal (%) (*n*= 90)

Species	Quantity share	Species	Value share
Acetes spp.	17.77	*Tenualosa ilisha*	18.66
Harpadon nehereus	15.38	*Harpadon nehereus*	12.25
Lepturacanthus savala	10.90	*Lepturacanthus savala*	12.09
Setipina tenuispinis	5.42	*Setipina tenuispinis*	5.79
Coilia dussumieri	4.23	*Sillaginopsis panijus*	5.15
Rastrelliger kanagurta	3.81	*Rastrelliger kanagurta*	4.10
Sillaginopsis panijus	3.52	*Pterotolithus maculatus*	3.51
Stolephorus spp.	3.19	*Coilia dussumieri*	3.22
Sardinella fimbriata	2.85	*Acetes* spp.	2.94
Tenualosa ilisha	2.69	*Sardinella fimbriata*	1.99
Pterotolithus maculatus	2.23	*Portunus sanguinolentus*	1.93
Megalaspis cordyla	1.99	*Plicofollis layardi*	1.86
Plicofollis layardi	1.74	*Sillaginopsis panijus*	1.70
Portunus sanguinolentus	1.55	*Coilia ramcarati*	1.63
Others	22.72	Others	23.18

Table 4. Species-wise composition in non-motorized fishing of Purba Medinipur district of West Bengal (%) (n= 90)

Species	Quantity share	Species	Value share
Stolephorus spp.	19.76	*Anodontostoma chacunda*	21.47
Eleutheronema tetradactylum	15.65	*Arius* sp.	11.57
Escualosa thoracata	13.82	*Brevitrygon imbricata*	9.98
Pomadasys maculatus	11.62	*Chrysochir aureus*	9.49
Hilsa kelee	11.50	*Coilia ramcarati*	8.45
Thryssa kamalensis	2.38	*Coilia dussumierii*	7.02
Deveximentuminsidator	1.52	*Eleutheronema tetradactylum*	2.65
Pterotolithus maculatus	1.40	*Escualosa thoracata*	2.31
Harpadon nehereus	1.34	*Harpadon nehereus*	1.96
Johnius spp.	1.25	*Hilsa kelee*	1.52
Others	19.76	Others	23.54

gillnets were economically more efficient than the boats fitted with engines. However, the amount of money, and subsequent profit generated or produced from mechanized fishing operations is far superior to that of motorized and non-motorized fishing operations, as evident from the values of Net Cash Flow and Gross Profit.

Among non-motorized fishing operations, the hook and line fishing method was found to be the most economically efficient. A similar view was expressed by Sathiadas and Panikkar (1988) when studying the non-motorized fishing operations from Trivandrum. Among motorized fishing operations, the Bag net fishing method was found to be

Table 5. Economic performance of Mechanized Fishing Operations (per trip) in Purba Medinipur district of West Bengal (n= 90)

Sl. No.	Component	Gill net	Trawl net
1	Crew wages (₹)	30716 (23.17)	41402 (17.75)
2	Crew bata value, including food, stores and provisions (₹)	6547 (4.94)	12385 (5.31)
3	Sub-total labour cost (₹)	37263 (28.11)	53787 (23.06)
4	Fuel cost (₹)	74100 (55.92)	153144 (65.63)
5	Auction charges (₹)	10239 (7.73)	13801 (5.92)
6	Other charges, including craft and gear repairs and maintenance (₹)	10920 (8.24)	12578 (5.39)
7	Sub-total input costs (₹)	95259 (71.89)	179523 (76.94)
8	Total operating cost (₹)	132522	233310
9	Catch (kg)	1937	2699
10	Gross revenue (₹)	204776	276106
11	Crew size (Number)	13	13
12	Net Cash Flow (₹)	72554	96493
13	Gross Profit (₹)	46661	76893
14	Net Profit Before Taxes (₹)	33202	63161
15	Net Profit Margin (%)	16.21	22.88
16	Return on Investment (ROI)	0.58	1.07
17	Capital Productivity (Operating ratio)	0.65	0.85
18	Labour Productivity (kg/crew/trip)	149	208
19	Input-Output Ratio	0.47	0.65
20	Gross Value Added (₹)	109817	150280
21	GVA as a per cent of Gross Revenue	53.63	54.44

Figures in parentheses indicate % to total operating cost

Table 6. Economic performance of Motorized Fishing Operations (per trip) in Purba Medinipur district of West Bengal (*n*= 90)

Sl. No.	Component	Gill net	Bag net
1	Crew wages (₹)	3153 (54.68)	2400 (44.37)
2	Crew bata value, including food, stores and provisions (₹)	720 (12.49)	1070 (19.79)
3	Sub-total labour cost (₹)	3873 (67.17)	3470 (64.16)
4	Fuel cost (₹)	1361 (23.60)	1144 (21.16)
5	Auction charges (₹)	328 (5.69)	432 (7.99)
6	Other charges, including craft and gear repairs and maintenance (₹)	204 (3.54)	362 (6.69)
7	Sub-total input costs (₹)	1893 (32.83)	1938 (35.84)
8	Total operating cost (₹)	5766	5408
9	Catch (kg)	90	364
10	Gross Revenue (₹)	8198	14413
11	Crew size (Number)	7	6
12	Net Cash Flow (₹)	2432	9005
13	Gross Profit (₹)	1843	8677
14	Net Profit Before Taxes (₹)	1728	8548
15	Net Profit Margin (%)	21.08	59.31
16	Return on Investment (ROI)	0.42	1.85
17	Capital Productivity (Operating Ratio)	0.70	0.38
18	Labour Productivity (kg/crew/trip)	12.86	60.67
19	Input-Output Ratio	0.23	0.13
20	Gross Value Added (₹)	6305	12475
21	GVA as a per cent to Gross Revenue	76.91	86.55

Figures in parentheses indicate % to total operating cost

Table 7. Economic performance of Non-motorized Fishing Operations (per trip) in Purba Medinipur district of West Bengal (*n*= 90)

Sl. No.	Component	Gill net	Shore seine
1	Crew wages (₹)	1551 (70.69)	5004 (75.52)
2	Crew bata value, including food, stores and provisions (₹)	475 (21.65)	1389 (20.96)
3	Sub-total labour cost (₹)	2026 (92.34)	6393 (96.48)
4	Fuel cost (₹)	0	0
5	Auction charges (₹)	114 (5.20)	205 (3.10)
6	Other charges, including craft and gear repairs and maintenance (₹)	54 (2.46)	28 (0.42)
7	Sub-total input costs (₹)	168 (7.66)	233 (3.52)
8	Total operating cost (₹)	2194	6626
9	Catch (kg)	32	174
10	Gross Revenue (₹)	3269	10240
11	Crew size (Number)	3	3
12	Net Cash Flow (₹)	1075	3614
13	Gross Profit (₹)	904	3396
14	Net Profit Before Taxes (₹)	861	3178
15	Net Profit Margin (%)	26.34	31.04
16	Return on Investment (ROI)	1.25	3.92
17	Capital Productivity (Operating Ratio)	0.67	0.65
18	Labour Productivity (kg/ crew/ trip)	10.67	58
19	Input-Output Ratio	0.05	0.02
20	Gross Value Added (₹)	3101	10007
21	GVA as a per cent to Gross Revenue	94.86	97.72

Figures in parentheses indicate % to total operating cost the best in terms of capital productivity, with the Gill net providing the least capital productivity. In an earlier study conducted by Raju *et al.* (2017) from Andhra Pradesh during 2003-2004, the average rate of return in non-motorized fishing operations was found to be superior when compared to motorized fishing operations.

Similar to Net Profit Margin, Return on Investment (RoI) was also the highest (1.25 to 3.92) in non-motorized fishing operations, signifying it to be the best in terms of financial performance. For non-motorized fishing operations, the average cost of assets is very low as the crafts are manufactured using wooden logs, but motorized crafts are made up of fibre-reinforced plastic (FRP), and hence, the asset cost is higher in motorized fishing operations. Motorized fishing operations, except Gill net (0.42) had low RoI. This could be attributed to the fact that Net Cash Flow and Gross Profit were low for Gill net motorized fishing operations, and therefore, could be considered to be financially inferior. In the present study, an RoI of only 0.58 to 1.07 was observed in mechanized fishing operations.

Capital Productivity was 0.5 to 0.85 for mechanized fishing operations, while for motorized and non-motorized fishing operations; it ranged from 0.38 to 0.70 and 0.65 to 0.67. This indicated that across all sectors, a minimum of 40% of the total income is available with the owner to cover the capital costs, and the rest is profit. Similar observations were made by Narayanakumar and Sathiadas (2005).

Input-Output Ratio was high (0.47 to 0.65) for mechanized fishing operations, whereas for motorized and non-motorized fishing operations, it was pretty low. The values ranged from 0.13 to 0.23 for motorized fishing operations and non-motorized fishing operations, it was close to nil. With high fuel usage in multiday fishing operations, input costs accounted for 72 to 77% of the operational costs of mechanized fishing operations, hence, a high Input-Output Ratio. On the contrary, in non-motorized fishing operations, input costs are very low (3.5% to 7.7%), due to the non-requirement of fuel for propulsion or fishing. Therefore, the ratio is non-existent. Sathiadas and Panikkar (1988) from Trivandrum reported that non-motorized fishing operations exhibit better Input-Output and Capital Productivity as compared to other fishing operations as the initial investment is comparatively less. Labour Productivity of 149 to 208 kg/crew/trip, as observed in the present study for mechanized fishing operations is on par with 232 kg/crew/trip recorded by Narayanakumar and Sathiadas (2005).

The maximum contribution to the economy in terms of cash or money was from mechanized fishing operations, as evident in the high values of GVA. Among both, motorized and non-motorized fishing operations, bag net and shore seine provided the best returns to the economy with a high amount of GVA, when compared to its counterparts. The share of the revenue that contributed to the economy was high for motorized and non-motorized fishing operations because of low input costs.

Conclusion

The analysis of the economic performance indicated that more than 55% of the total operational cost in mechanized fishing operations goes to fuel expenses. The consistent and continuous increment in the expense of fuel and declining market value of the catch lately has adversely affected the benefit. Further, an increase in production from marine capture fisheries can only be achieved through judicious management of fishery resources, proper utilization of harvested products using or enhancing shore-based facilities, implementation of the Code of Conduct for Responsible Fisheries (CCRF), participatory management and diversifying to deep sea fishing operations. With higher operating expenses incurred for most fishing operations, as evident in the values of financial indicators obtained in the present study, it is recommended to set up a different budgetary foundation for offering monetary types of assistance at a lower financing cost amid hardship. This would be useful to dispose of the agents, who give money effectively yet at a higher financing cost, therefore, ensuring higher profitability for fishing operators. The study recommends optimization of resource use to improve the techno-economic efficiency of single-day fishing operations (both motorized and non-motorized).

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