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Economic efficiency indicators of multi-day trawl fleet in Digha, north-east coast of India

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Original Article

Abstract

Digha Mohana is a major fish landing and auction centre on the Northeast coast of India that supports livelihood and contributes to fisheries export. Trawl fishing is the major fishing operation observed in the region, where multi-day operations (MD) less than six days and > 6 days are in practice. In this study, we collected primary data on input and output factors in these two fleets to investigate the economic efficiency in fishing operations for 2018-2019. In this case, it is essential to study the economic efficiency of the trawls to sustain both the fishing industry as well as the marine environment. The analysis revealed that the mean cost incurred per fishing day was high for more than 6 days than MD (<6 days) fishing. MD trawlers (<6 days) were found to be labour efficient as well as earned more carbon credit by releasing less carbon dioxide during fishing operations in terms of fuel quantity and the value as compared to MD trawlers (> 6 days). The economic efficiency assessed through the different indicators revealed that the trawl operations were profitable with more than 6 days than the less than 6 days operations.

Keywords: *Economic efficiency, labour efficiency, fuel efficiency, profitability ratios*

Introduction

The fisheries sector plays an important role in the Indian economy, contributing a consistent share to the GDP. Over the years, dynamic changes have taken place in the Indian fishery scenario. Maritime state and central governments have introduced many management interventions from time to time. Changes also have taken place in the crafts and gear, fisherfolk population structure, availability of resources and their spread, infrastructure facilities, and management measures. The marine fisheries sector in West Bengal, with a coastline of 158 km, plays a crucial role in the overall economic development of the state. West Bengal has made up about 231 billion Indian rupees in gross value added from fish products towards agriculture across India in the fiscal year 2018. The GVA from this state has contributed over 17 percent of fish products nationwide. Fishing had contributed over 1.3 trillion rupees in GVA in the Indian economy that fiscal year (Statista Research Department, 2021). There are 171 marine fishing villages and 49 marine fish landing centres in West Bengal (CMFRI, 2016). About 14,282 mechanized units and 3,066 motorised and non-mechanised units are engaged in marine fishing activities in the state. Trawlers (49.92 %), Gill netters (43.94%), and bag-netters (4.75 %) are the main crafts in the mechanized fishing sector. The human resource potential of the marine fisheries sector includes 81,067 families with a total fisher population of 3,68,816 (CMFRI, 2016). West Bengal comprises 23 districts and out of which there are two coastal districts *viz.* South 24 Parganas and Purba Medinipur. The South 24 Parganas district is dominated by a magnificent mangrove cover (Sundarbans) on the eastern part along the banks and inlands amidst the tributaries network. The southern edge of Purba Medinipur district is exposed to the sea, the Bay of Bengal. The major landing centres are situated in(1) Digha, (2) Digha Mohana, (3) Shankarpur, (4) Petuaghat, (5) Sagar, (6) Fresergunge,(7) Namkhana, (8) Kakdwip and (9) Diamond Harbour.

The marine fish production in West Bengal during the year 2018-2019 was estimated as 1.6 lakh tonnes (CMFRI, 2019a), contributing 4.6% to the total marine fish production in the country. The landings were decreased by about 56% compared to the previous year (2017-18) (3.6 lakh t). The total marine fish valuation of West Bengal at the landing centre for the year 2018 was found to be 2759 crores (Shyam *et al.*, 2019). The mechanized and the motorized sectors contributed 88% and 10% of the total landings, respectively, while the non-mechanized/ traditional sector contributed only 2%. Analysis of catch and effort data for the period 2007- 2018 revealed that the highest catch (3.65 lakh t) was in 2011, which fluctuated a lot since then. The unusual decrease in the marine fish landings in 2018 was mainly due to a decrease in fishing effort, which reduced by about 49 % and 52% in terms of fishing units and Actual Fishing Hours (AFH), respectively, compared to the previous year. It is mainly due to adverse natural calamities like frequent development of low pressure zones and cyclones over Bay of Bengal (CMFRI, 2019a).

Digha Mohana fish landing centre, is the largest mechanized fish landing centre and auction market in Purba Medinipur district of West Bengal. Hence the landing site occupies predominant place in the marine fish production of West Bengal. Earlier, gillnetters (51%) were more followed by trawlers (34%) and bagnetters (15%) in the mechanised sector of Purba Medinipur. But in the recent years, it has been observed that there is a shift towards trawlers by the fisher-folk due to their technical efficiency and catch of high priced fish like pomfrets, sciaenids, shrimps, sharks, and rays. The mechanized trawlers (50%) showed a tremendous increase in the fishing fleet of Purba Medinipur followed by mechanized bag netters (20%) and mechanized gillnetters (15%), inboard bag netters (8%), inboard gillnetters (2%), and other 2% due to their assured returns and consistent marketing margin. Trawlers contributed nearly 79964.6 tonnes to the total marine catch of West Bengal, of which 51084.8 tonnes (64%) was the targeted/ high valued catch (HVC). With a landing of 28879.8 tonnes, low valued by-catch (LVB) constituted about 36% of the trawl landings in west Bengal during 2018. However, due to the non-selective fishing, there are more by-catches, including juveniles.

The over exploitation of fisheries resources with irrational fishing has caused tremendous pressure on the marine resources, especially within the zone of 50-60 m depth creating management and financial problems in the fishing sector (Narayanakumar, 2012). Reductions in the catch per unit effort and increasing cost of fishing inputs made the investment in mechanized fishing a risky affair (Shyam *et al.*, 2014). Here, the covering factor is the continuous increase in the price of fishes that the fishing units are able to earn moderate profits. The depletion in the stock of resources targeted by the mechanized units and the rising fuel prices pose a serious threat to the economic viability of most of the mechanized fishing units (Aswathy *et al.*, 2011).

For the benefit of the fishers and the fisheries sector, the Central Marine Fisheries Research Institute conducts various case studies on the cost and earnings of different types of fishing units in the recent period. The economic performance of marine fishing operations is affected by various factors *viz.,* diminishing catch per unit of effort, fluctuations in revenue, and unforeseen increases in the cost of key inputs as well as catch and effort regulations. Economic performance plays a crucial role in investment decisions at the micro level.

The economic efficiency of trawl fishery has been analyzed in India by Narayanakumar *et al.* (2009), Aswathy *et al.* (2011), Renju Revi *et al.* (2014) in Kerala, and Geetha *et al.* (2014) in Tamil Nadu, etc. There are no reports available on the economic efficiency of the trawl fleet in West Bengal. In this context, the present study compares the economic efficiency of mechanized trawler operation (MD>6 days and MD<6 days) across different duration operated in Digha fishing harbor. The objective of the study is to assess the viability of various mechanized trawl operations (MD>6 days and MD<6 days) in the Digha fishing harbor using different economic and financial indicators. Thus, the study will provide vital information for framing appropriate policies for the balanced and sustainable development of the marine fisheries in the state.

Material and methods

The primary data on investment, operational costs and earnings were collected from ten mechanized trawlers units operating at Digha fisheries harbor for less than 6 days and more than 6 days during 2018-19). The costs and earnings data were collected for 10 days every month. Data on quantity and value of different species caught by the units, wages to laborers, fuel expenses, auction charges, expenses on repair and maintenance and other operational expenditures, cost of various inputs, details of craft and gear, crew details, and capital investment were

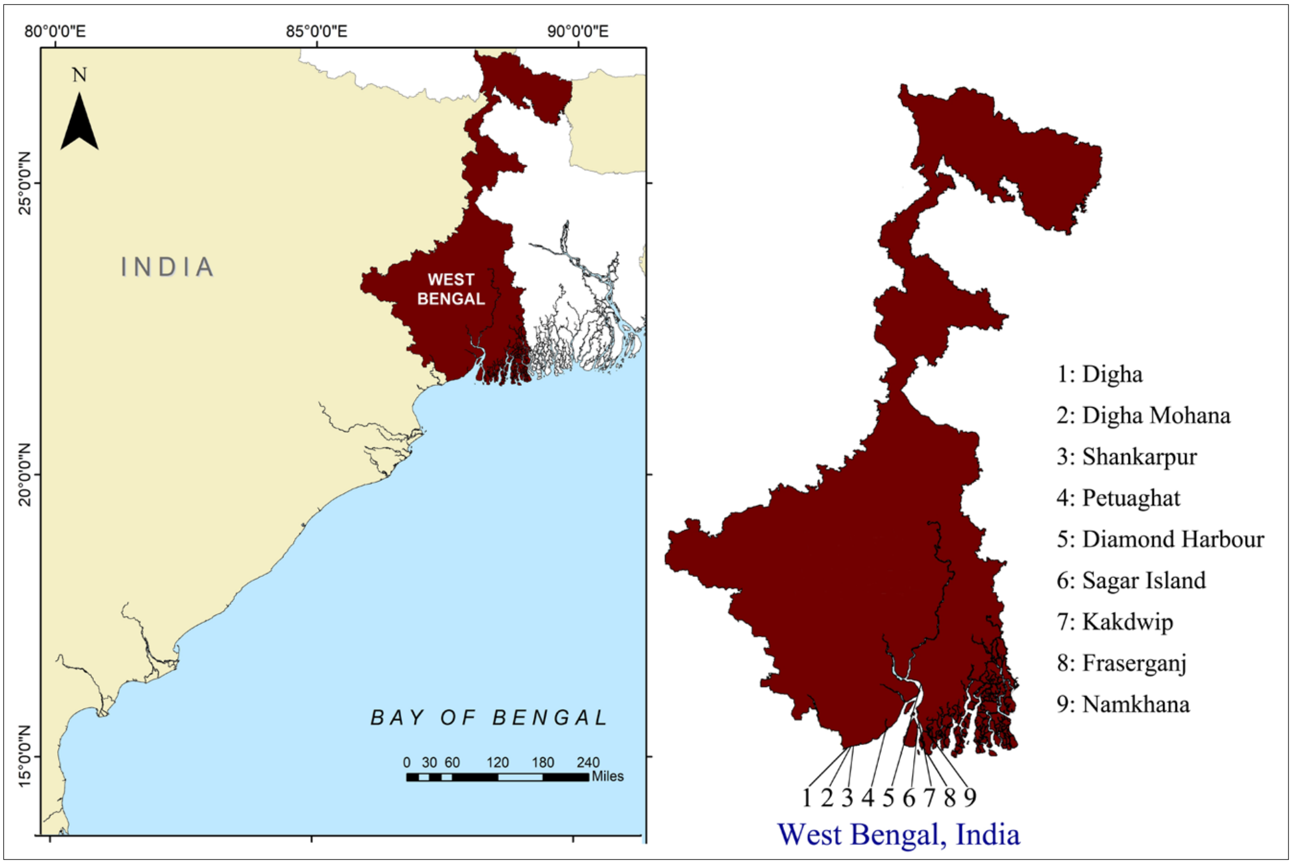

Fig. 1. Map of the study area

collected from the randomly selected units for a period of one year through a pilot-tested survey schedule Fig. 1.

The details on the fixed cost included the cost of the fishing equipments; insurance premium paid and related investment particular ₹ (in INR) from this the annual fixed cost was worked out by adding the depreciation on fishing equipment, insurance premium paid, and the interest on fixed capital. Both primary and secondary data were collected and used for the study. The secondary data pertaining to the fishing craft and gear, marine fish production over the years by different sectors, and socio-economic data were collected from publications of CMFRI and statistical reports of the Government of India (CMFRI, 2019b; CMFRI, 2018; DOF, 2019)

The analysis of the economic performance of fishing methods was assessed by working out the fixed cost, operating cost per trip, gross revenue per trip, net operating income per trip, and annual net income through tabular analysis. The capital and labor productivity were also worked out using operating ratio and catch per labor per trip, respectively to assess the economic performance (Sathiadhas, 1996). In general, operating ratio, net profit, capital, labor productivity, input-output ratios, gross value added were worked out as the indicators of economic efficiency of the unit.

Cost-income ratios were used to measure the overall input and output efficiency in terms of value. The operating cost ratio relates variable costs to gross income. The revenue or the gross income of a unit is the sum total of value by multiplying the quantities of different species/groups with their respective price.

$$\text{Operating ratio} = \text{Operating costs / Gross returns} \quad (1)$$

The primary data were collected on operating costs per trip, which included the cost of fuel, crew wages, food expenses, auction charges, repair and maintenance, and other day-to-day expenses for carrying out fishing operations. The operating cost per trip was thus calculated as follows.

$$\text{Operating cost /trip} = (\text{Fuel} + \text{Crew wage} + \text{Food} + \text{Auction} + \text{Repair} + \text{Other charges})\ldots.(2)$$

The gross revenue per trip was calculated from the species composition of catch and price per species. The gross revenue per trip was estimated as follows.

$$\text{GR per trip} = \sum_{i=1}^{n} q_i\, p_i \quad (3)$$

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
Labor productivity = Gross catch / Man days

Net profit is the profit obtained after deducting operating expenses, depreciation and interest from the gross income earned.

Results and discussion

The economic efficiency of mechanized trawlers in terms of various key economic indicators was estimated on the basis of costs and returns data. The economic performance of the trawling operations were analyzed, and the annual cost and returns, net operating income, net income and other productivity measures were estimated.

Fishing operations

The trawlers operate multi-day fishing operations of less than 6 days and more than 6 days are of average 15-18 m overall length with engine horsepower ranging from 200-300. There was no significant difference between the crafts in terms of size and engine power for the different multi-day operations. The average crew size was found to be 15 (range:14-16) in MD >6D and 16 (ranged 15-17) for the multi-day less than 6 days (MD < 6D) fishing. The multi-day trawlers (MD >6D) normally operate along the West Bengal waters at 80-100m depth, 50-60 km towards the east (21°38′56′′N&87°53′48′′E) away from Digha for better catch starting from morning to afternoon. The fleet usually takes 4-5 hauls every day with an average active trawling operation of 3-4 hours between each haul depending on the availability of resources. On the other hand, the trawlers (MD<6 D) operate between 30-60 m depth, towards the south-east direction from Digha, making 3-4 hauls per day in a 3-4 hours' duration. During the trawling, the geo-coordinates for each trawl net deployment are meticulously recorded by the fishermen for their subsequent use in future operations depending on the resource abundance of the location (Sen *et. al.*, 2020). The multi-day trawlers with trawlnets having diamond shaped cod end mesh (mesh size: 20 mm) operate mainly to target bigger sciaenids (*Protonibea diacanthus*, *Otolithoides biauritus*), ilisha (*Tenualosa ilisha*), ribbonfishes (*Trichiurus lepturus, Lepturacanthus savala*) and pomfrets (*Pampus argenteus, Pampus chinensis* and *Parastromateus niger*).

Cost of fishing

The operational expenses varied between MD >6D and multi-day less than 6 days (MD < 6D) fishing. The operational expenses include crew share (bata and wage), provisions (food), ice, starter oils, fuel (kerosene and diesel), water charges, auction charges, and expenses towards net repairing and maintenance and other petty expenses. The average operational expenses for the different trawl operations is given in Table 1.

The operational expenses indicated that the multi-day more than 6 days fishing required an operational expenditure of ₹3,15,968 per trip when compared to ₹2,54,552.66 for the multi-day less than 6 days. Fuel and crew share contributed for more than 73.54 and 67.99 per cent of the total expenses. Among the fuel cost more than 99.79 percent was required for the diesel and the rest for kerosene for engine start-up. The average diesel consumption varied with around 1345 litres of diesel for multi-day less than 6 days and 2125 liters for multi-day more than 6 days. The crew share included the bata, wages and salary for the engine driver. More than 50% of the share was contributed by the bata (50.32% in case of more than 6 days and 53% in case of less than 6 days). The share of wage was 38.22% in case of more than 6 days and 39.34% in case of less than 6 days). The engine drivers were paid around 11.46 and 7.66% of the crew share for trawl operation more than 6 days and less than 6 days respectively. The average ice usage was 55 blocks (120 kg blocks costing

Table 1. The average operational expenses of trawl operations per trip

	MD >6D		MD <6D	
Components	Amount (Rs)	Share %	Amount (Rs)	Share %
Starter Oil	7811.11	2.45	3233.33	1.27
Fuel	144825.6	45.44	91735	36.04
Crew share	89544.89	28.10	81335	31.95
Provisions	20777.78	6.52	16333.33	6.42
Ice	13844.44	4.34	14000	5.50
Auction charges	26997	8.47	24916	9.79
Water Charges	2008.89	0.63	2833.33	1.11
Others	12888.89	4.04	20166.67	7.92
Total	318698.55	100.00	254552.66	100.00

₹250 per block), which accounted 4-5% of the operational expenses. The auction charges varied between 8-10% across different trawling operations. The operating cost without labor for multi-day more than 6 days and less than 6 days was found to be ₹229153.66 and ₹173217.66, respectively.

The average fixed cost per trip was assessed based on the depreciation and accordingly, ₹7967 was incurred for multi-day more than 6 days and to ₹6363.82 was incurred for the multi-day less than 6 days. The average total cost per trip was found to be ₹3.26 lakhs for multi-day more than 6 days and ₹2.61 lakh per trip was incurred for the multi-day less than 6 days. The average operating cost per fishing day was ₹39, 837.32 and ₹50,910.53, respectively for multi-day more than 6 days and multi-day less than 6 days.

Fish catch and species composition

The average landings for the multi-day more than 6 days and multi-day less than 6 days was found to be 3025 and 2190 kg, respectively. The major resources landed in the multi-day trawl operations included Ribbon fishes (20%), Croakers (17%), Pomfret (13%), Cat fishes (11%), flat fishes (9%), Bombay duck (9 %), Penaeid prawns (8%), Hilsa Shad (5%), Polynemids (4%), and Seer fishes (3%) and tuna (1%). The average price per kg was found to be ₹230.46 and ₹235 respectively for multi-day more than 6 days and multi-day less than 6 days respectively. The average revenue realized was found to be ₹6.97 lakhs in the case of multi-day more than 6 days and ₹5.15 lakhs for multi-day less than 6 days fishing. The average revenue per fishing day was 87143.44 and 103008.49 for multi-day more than 6 days and multi-day less than 6 days. The net profit per trip was found to be ₹3, 78,448.95 and ₹2, 60,489.79 for multi-day more than 6 days and multi-day less than 6 days of fishing.

Input Usage

Labour efficiency

Labour efficiency is often measured by dividing total output by units of labour engaged. An analysis of labour productivity showed that MD trawlers more than 6 days earned ₹5809 per labour man day while for MD trawlers less than 6 days, it was ₹6438.03 per labour man day. The labour efficiency was higher for MD trawlers less than 6 days as the catch per man day was 27.40 kg as compared to 25.21 kg on a MD trawlers more than 6 days. Thus, the MD trawlers less than 6 days were labour efficient as compared to MD trawlers more than 6 days.

Fuel efficiency

The MD trawlers less than 6 days consumed 613 litres of diesel on an average to catch one tonne of fish whereas MD trawler MD trawlers more than 6 days consumed 702 litres of diesel on an average to catch one tonne of fish. The average fuel cost per fishing day worked out to be ₹18065 for MD trawlers more than 6 days and ₹18293 for MD trawlers more than 6 days.

The Quantity of fish production per litre of fuel for MD trawlers more than 6 days was 1.42 and MD trawlers less than 6 days was 1.63 kg respectively. The study revealed that MD trawlers less than 6 days earned more carbon credit by releasing less carbon dioxide during fishing expeditions in terms of fuel quantity and value. An incremental gain of 89 litres of diesel equivalent to 235 kg of CO_2 saved for every ton of fish caught in multi-day trawl operations of less than 6 days (Shyam *et al.,* 2019)

Indicators of assessing economic efficiency

The economic efficiency assessed through the different indicators is given in the Table 2.

The indicators assessing the economic efficiency included operating ratios, rate of return, profitability ratios, net profit ratios and input output ratios. These ratios assess the economic efficiency of gross return, operating cost and total cost revealed that the trawl operations with more than six days are more profitable than less than 6 days operations.

Conclusion

Digha is a major revenue generation point for fisheries sector in West Bengal. Hence, it is highly essential to study the economic efficiency of the most demanded multi-day trawlers to sustain

Table 2. The economic efficiency indices of different multiday trawl operations.

Economic efficiency indices	MD >6D	MD <6D
Operating Ratio	0.46	0.49
Rate of Return	1.16	1.00
Profitability Ratio	1.19	1.02
Net Profit Ratio	0.54	0.51
Input- Output Ratio- (Total input cost/Gross revenue)	0.33	0.34

the fisheries sector as well as the aquatic environment. The present analysis clearly depicts that the operational expenses and fixed cost per trip are higher for multi-day trawlers operating for more than 6 days compared to the trawlers operating for less than 6 days. Though the average revenue realized was found to be higher in the case of multi-day trawlers operating for more than 6 days compared to the trawlers operating for less than 6 days, the average revenue per fishing day was less in former compared to the latter. Moreover, the labour and fuel efficiency were higher in multi-day trawlers operating for less than 6 days compared to the trawlers operating for more than 6 days which clearly indicates that former fishing practice is more fuel efficient resulting in a lower carbon footprint during actual fishing operation. As far as the pure economic indicators are concerned, the trawl operations for more than 6 days are more profitable compared to trawls that operate for less than 6 days. Nevertheless, the excessive use of fuel in trawl fishery could be considered as a major issue in the context of global warming and therefore, it is essential to popularize the fuel-efficient and eco-friendly fishing practices through policy interventions.

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