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Techno-economic evaluation of marine fishing operations in Andhra Pradesh, southern India

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ABSTRACT

The marine fish landings in Andhra Pradesh during 2020 was estimated at 1.95 lakh t, contributing 7.2% of the total marine fish landings in the country. The techno-economic evaluation of different fishing methods in Andhra Pradesh was carried out for assessing the economic efficiency. The boat and net combinations throughout the year have seen spectacular changes because of enormous expense on fishing, time taken for fishing and prefunding of activities and support. Fuel accounted for the major share (75.8%) in operational costs of mechanised crafts. In motorised crafts, the contribution of fuel to operational costs ranged from 11.9 to 33.2%. Crew wages, which formed only 12.8% of the operational costs in mechanised crafts, contributed the major share (67.8 to 84.2%) in motorised crafts. In non-motorised crafts, almost the entire operational cost was towards crew wages. Net Profit Margin and Return on Investment was 35.2 and 2.16% for mechanised fishing operations, 37.5 to 44.3% and 0.91 to 2.77 for motorised fishing operations and 40.7 to 44.7% and 3.78 to 5.17 for non-motorised fishing operations, indicating non-motorised fishing operations to be the most economically efficient method. Capital productivity and Input-Output Ratio was 0.6 and 0.5 for mechanised fishing operations, 0.54 to 0.60 and 0.09 to 0.19 for motorised fishing operations and 0.54 to 0.59 and close to nil for non-motorised 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. The major fishery resources landed in various fishing operations were penaeid shrimps, sardines, Indian mackerel, ribbonfishes, catfishes, carangids and anchovies. In fishing tasks, the expanded expense of fishing per trip, the diminished landings and ensuing decrease in the gross returns per trip have been cited by the fishers as significant factors influencing the financial returns from various fishing methods.

Keywords: Capital productivity, Costs, Gross value added, Input-output ratio, Labour productivity, Returns

Introduction

Marine capture fisheries serve as a significant source of employment, income and foreign exchange earnings, besides providing nutritional security to the populace. The domain has changed from subsistence fishing to the position of a multi-billion industry due to dynamic technological changes in both harvest and post-harvest methods. For achieving the objectives of United Nations Sustainable Development Goals (SDG 14), it is imperative that fishing operations should 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 are only available in isolated patches and regions. This when used for national computations, often leads to erroneous estimates. Besides, lot of structural changes has taken place in the socio-techno-economic aspects of fishing, which has far reached implications in the performance of the sector.

The state of Andhra Pradesh ($12^0$41' and $19^0$07'N; $77^0$00' and $84^0$40'E) in India is bordered by Telangana, Chhattisgarh and Odisha in the north, the Bay of Bengal in the east, Tamil Nadu to the south and Karnataka to the west (Fig. 1). The marine fishery of Andhra Pradesh cover 974 km of coastline encompassing a continental shelf area of 33,227 sq. km, 533 marine fishing villages and 234 marine fish landing centers scattered in 9 coastal districts (CMFRI-DoF, 2020). About 1,176 mechanised crafts and 12,078 motorised and 6,965 non-motorised crafts are occupied in marine fishing activities in the state. The motorised sector contributed nearly 57% of the marine landings of the state in 2020 (CMFRI, 2020). The human resource capability of the marine fisheries sector comprises 1.55 lakh families with an overall populace of 5.17 lakhs. The marine fish production in Andhra Pradesh for 2020 was assessed at 1.95 lakh t (CMFRI, 2020), contributing 7.2% of the total marine fish production in the country. The fish landed comprised pelagic (68%), demersal (20%), crustaceans

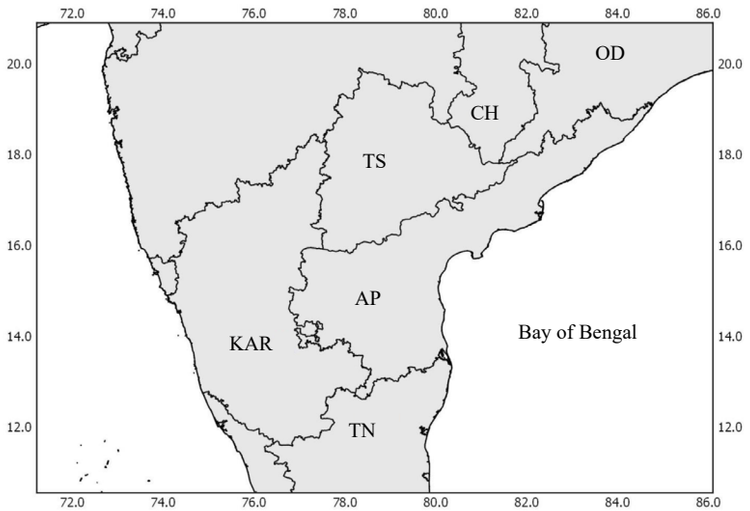

Fig. 1. Map of Andhra Pradesh showing its neighboring states. AP- Andhra Pradesh; TN-Tamil Nadu; KAR-Karnataka; TS-Telangana; CH-Chhattisgarh; OD-Odisha

(9%), molluscan (2%) and miscellaneous (1%) resources. The major resources of Andhra Pradesh include Indian mackerel, lesser sardines ribbonfishes, croakers, pomfrets, penaeid shrimps and crabs (Muktha *et al*., 2018). The valuation of the marine fish landings of the state during 2020 was estimated at ₹2,675 crores at landing and ₹4,345 crores at retail centre level. The price per kg of fish at arrival centre was ₹137 and at retail centre was ₹223 (CMFRI, 2020). During 2009-10, the total value of marine exports from Andhra Pradesh was ₹2,100 crores, which was 20% of the total seafood exports from the country, which enhanced to about ₹15,832 crores during 2020-21. The sector is providing employment to nearly 14.5 lakh people directly and indirectly. Recognising the importance of the fisheries sector, the Government of Andhra Pradesh has identified it as one of the 'Growth Engines' among seven missions under primary sector for socio-economic development (DoFAP, 2020).

The marine fisheries sector is plagued with management and financial bottlenecks, more so, within the zone of 50-60 m depth. Overexploitation of resources caused by use of destroying nets and strategies for fishing has caused huge tension on the fishery assets (Narayanakumar, 2012). Decrease in the amount of catch per unit exertion caused by the depletion in the stock of resources coupled with the increasing cost of fishing inputs, particularly fuel have caused investment to be risky in capital intensive mechanised fishing units (Narayanakumar and Sathiadhas, 2005; Aswathy *et al.*, 2011). However, notwithstanding the associated risks, mechanised crafts, over the years have realised the maximum net profit from fishing operations (Radhakrishnan *et al.*, 2018). Though with the advent of mechanisation, the fish landing increased in Tamil Nadu, it adversely impacted the livelihood of traditional fishermen, who have recorded dwindling catch rates and left their occupation to work as crew/labour in the mechanised sector (Sathiadhas and Venkateshwaran, 2000). The problems in fishing are numerous and are caused due to inter-sectoral conflicts driven by economic performance. For the benefit of the fishers and the fisheries sector, ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi has been undertaking primary studies on cost and earnings of different types of fishing crafts for the past three decades. The financial performance of marine fishing units in the country is influenced by different variables *viz,* reducing catch per unit effort, fluctuations in income and unanticipated rise in the expenses of major inputs and catch and effort limitations. The financial performance very much decides the investment decisions at the micro level.

The craft and gear combination in Andhra Pradesh had undergone dramatic changes in the past decade by virtue of 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 appropriate fishery policies, it is essential to contemplate the relative financial aspects of different types of fishing methods and gears operated in Andhra Pradesh. 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 motorised and traditional fishery by Venkata Raju *et al*.

(2017), studies are very limited in the recent past. The most important aspect, *viz.* economic performance/efficiency of different fishing methods, which rules the multimillion fishing industry of the state, has been totally ignored, and it is of no surprise, that the marine fishing industry of the state is in collapse (Shubhadeep Ghosh *et al*., 2015). It is in this setting that the current investigation on comparing the economic efficiency of various crafts and gears in Andhra Pradesh assumes paramount importance. The study investigated the suitability of different fishing craft gear combinations utilising diverse monetary indicators for effective fisheries governance. The economic analysis of marine fishing in the present manuscript will provide crucial data for devising suitable strategies for the fair and feasible improvement of the marine fisheries in Andhra Pradesh and when replicated for other maritime states, can lead to the development of a national policy document on techno-economic performance of fishing fleets.

Materials and methods

The information on investment, operational expenses and returns of different craft -gear combinations were gathered from 10 fishing units under each category working at Chintapalli landing centre (Vizianagaram District), Bandaruvanipeta landing centre (Srikakulam District) and Visakhapatnam Fishing Harbor during the triennium period (2017-2018 to 2019-2020). The costs and returns data were gathered for 10 days in each month from ten sample units. Information on amount and estimation of various finfish/shellfish groups 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 randomly chosen units 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 year by various areas and socio-economic conditions were gathered from different reports of ICAR-CMFRI and factual reports of the Govt. of Andhra Pradesh.

The economic performance of fishing techniques was evaluated by working out the operating expense, gross income and net income per fishing trip. The capital and labour productivity were worked out by utilising crew share and catch per person per trip (Sathiadhas, 1989). Net income, capital productivity, labour efficiency (kg person^{-1} trip^{-1}), input-output ratios, Gross Value Added and Gross Value Added as a percent to Gross Revenue (Narayanakumar *et al*., 2009) were worked out as the indicators of financial performance of various fishing units.

Input-output ratio is the ratio of all inputs (excluding labour cost) to the gross revenue. Operating ratio relates variable expenses to gross revenue. The income or the gross revenue of a unit was obtained by multiplying the quantities of landings of various species/groups with their respective prices.

Input-Output ratio = Input expenses/Total Revenue..(1)

Operating ratio = Operating expenses/Total Revenue….(2)

The essential information was gathered on operating expenses per trip, which incorporated the expenses of fuel, labour charges, food costs, auction charges, upkeep and other miscellaneous expenses for completing the fishing tasks. The operating expense per trip was calculated as follows:

Operating cost per trip = (Fuel + Labour charges + Food costs + Auction charges + Upkeep charges + Other expenses) ..... (3)

The gross income per trip was determined from the quantities of different species in the total catch and value per species. The gross income per trip was assessed as follows.

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

where, qi is the amount of catch in kg of the ith species and pi is the price per kg of ith species

Labor productivity = 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 total of what expenses have been represented and mirrors the level of income that a vessel proprietor holds as benefit.

Return on Investment (ROI) = NPBT / Value of assets.....(10)

The return on investment is the most commonly used indicator for financial performance.

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 investment in fisheries sector and expenditure decisions.

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

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

Results and discussion

Review on financial aspects of various kinds of fishing units showed that practically all sort of fishing units, on a normal, run-on benefit as their production exceeds the breakeven point (Sathiadhas, 1989; Narayanakumar *et al.,* 2009). Despite the expansion in crafts and the reduction in the catch rates, the fishing sector is able to sustain mostly because of the rise in the prices of nearly, all the types of fishes. Be that as it may, attributable to open-access nature of marine capture fisheries and the intense competitions for resources associated with it, many of the less efficient fishing units are as a rule gradually eliminated of activity because of the misfortunes. Hence, the relative financial effectiveness of various craft-gear combinations as far as different key economic indicators was assessed based on costs and returns data.

Fishing operations

Mechanised fishing crafts: Trawlers, with an average overall length (OAL) of 48-50 feet and powered by engines with capacities of 190-200 HP are the principal crafts under this category and perform, mostly multi-day fishing operations ranging from 4 to 5 days. Due to targeted fishing, shrimp dominates the trawl landings. The use of semi-pelagic trawls, in recent times, resulted in significant landings of Indian mackerel, lesser sardines and carangids. In bottom trawls, targeting demersal finfishes, sciaenids, goatfishes, threadfin breams, lizard fishes and silver bellies are caught. Shrimps, pomfrets, Indian mackerel, lesser sardines and seefishes are the most valued trawl resources. The high value realised for penaeid shrimps, pomfrets and seerfishes is because of its demand in both export and domestic markets. The high revenue from Indian mackerel is because of its demand from other states, chiefly Karnataka, Kerala and Tamil Nadu.

Motorised fishing crafts: The motorised crafts, mostly operating hook and line, trammel nets (*Discovala*) and a variety of small-meshed gill nets (*Jogavala* and *Naravala*) perform single day fishing operations and are of an average of 13-30 feet OAL with engine power ranging from 9-10 HP. *Discovala*, a triple layered gill-net, is chiefly employed in the near shore waters to catch penaeid shrimps. Catfishes, snappers, eels and seerfishes are caught chiefly in *hook and line*. The two, small-meshed gillnets (*Jogavala* and *Naravala*) land mostly, sciaenids, horse mackerel, ribbon fishes, crabs, Indian mackerel and anchovies. Penaeid shrimps, snappers, catfishes, eels and seerfishes are in high demand both in domestic as well as in export markets.

Non-motorised fishing crafts: The traditional/non-motorised crafts, operating hook and line and *Naravala* have an average OAL of 24-27 feet. *Hook and line* land mostly catfishes, snappers, seerfishes, eels, groupers, rays, grunters and tunas. The catch in the small-meshed gillnet (*Naravala*) comprised chiefly of penaeid shrimps, Indian mackerel, threadfin breams, horse mackerel, sciaenids, wolf herring and ribbon fishes. Details of fishing operations by mechanised, motorised and non-motorised 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 (75.8%) in operational costs of mechanised 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 the same study area. In motorised crafts, share of fuel in the total operational cost ranged from 11.9% in case of *Naravala* to 33.2% in *Jogavala*. However, higher contribution by fuel to operational costs in motorised crafts, ranging from 35 to 42% was earlier reported during 2003-2004 by Venkata Raju *et al*. (2017). On the contrary, crew wages which formed only 12.8% of the operational costs in mechanised crafts, contributed the major share,

Table 1. Technical profile of fishing equipment and fishing pattern in Andhra Pradesh for the triennium 2017-2020

Particulars	Mechanised (MDF)	Motorised (SDF)				Non-motorised (SDF)	
		Discovala	*Jogavala*	*Hook and line*	*Naravala*	*Hook and line*	*Naravala*
Overall length (OAL) (feet)	48-50	21	13	29	30	24	27
Engine (HP)	190-200	9	9	9	10	0	0
Number of crew	7-9	6	6	6	6	3	4
Depth of fishing (m)	30-31	10	10	10	11	10	18
Distance to fishing ground km)	30	20	20	20	17	10	9
Number of hauls per trip	3-4	3	3	3	1	3	1
Duration of haul (h)	2-3	2	2	1	1	3	1

ranging from 67.8% (*Jogavala*) to 84.2% (*Naravala*). Similar findings on labour costs to be significantly higher in motorised crafts were reported from Kerala by Balan *et al*. (1989).

In non-motorised crafts, almost the entire operational costs were towards crew wages. There was no expense towards fuel as non-motorised crafts are driven by the power of wind using sails. For most EU mechanised fleets, input costs were either comparable or more than labour costs (Carvalho *et al*., 2020). In Turkey, UK and Italy, input costs (25% to 61%) were higher than labour costs (21 to 34%). In Spain and France, for demersal trawlers which comprise long distance fleets, input costs were more (33 to 53%). On the contrary, for Norway and Germany, which do trawl in nearshore waters, inputs costs (15 to 26%) were comparatively less (Carvalho *et al*., 2020). Also, as found in the present study, for smaller fishing crafts, in most European countries, labour costs are the highest cost component (Carvalho *et al*., 2020). Unlike our results, wherein vessel repairs and maintenance formed an insignificant amount, it contributed substantially to fleets of EU, mostly because of the larger size and capacity of these industrial fleets.

The average total value of assets (including craft, engine, propeller, gear, rope and all other accessories required to perform fishing) was ₹63.57 lakhs for a mechanised unit, whereas for motorised unit, it was ₹2.09 lakh and for non-motorised unit it was ₹0.66 lakh. Annual depreciation of mechanised crafts was high (₹5,13,350), whereas for motorised (₹26,900) and non-motorised crafts (₹8,600), 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 (₹3,81,400) for mechanised crafts and very low for motorised (₹12,500) and non-motorised (₹4,000) crafts.

The marine fisheries of Andhra Pradesh exhibited seasonal variations to a great extent and the quantity-wise and value-wise landings of major species in mechanised motorised and non-motorised fishing (average for the triennium 2017-20) are given in Tables 2, 3and 4.

The economic performance of mechanised, motorised and non-motorised fishing operations is presented in Tables 5, 6 and 7. It is seen from the tables that the net profit margin was highest (40.7 to 44.7%) for non-motorised fishing operations, followed by motorised fishing operations (37.5 to 44.3%) and the lowest (35.2%) was in mechanised fishing operations. A Net Profit Margin higher than 20% is considered to be good with higher operating efficiency. This indicated non-motorised fishing operations to be the most profitable and mechanised fishing operations to be the least profitable. Similarly, Sathiadas (1989) when comparing the financial efficiency of sailboats operating various fishing nets in Tamil Nadu concluded that non-motorised sailboats operating gillnetters were economically more efficient than the boats fitted with engines. However, the amount of money and subsequent profit generated or produced from mechanised fishing operations is far superior to that of motorised and non-motorised fishing operations, as evident from the values of Net Cash Flow and Gross Profit.

Among non-motorised fishing operations, *hook and line* fishing method was found to the most economically efficient. Similar view was expressed by Sathiadas and Panikkar (1988) when studying the non-motorised fishing

Table 2. Share of different finfish/shellfish groups in mechanised fishing in Andhra Pradesh (2017-20)

Group	Quantity share (%)	Group	Value share (%)
Penaeid shrimps	14.12	Penaeid shrimps	32.53
Indian mackerel	8.11	Pomfrets	8.57
Lesser sardines	6.93	Indian mackerel	7.33
Goatfishes	6.77	Lesser sardines	6.03
Sciaenids	6.50	Seerfishes	4.84
Carangids	5.14	Threadfin breams	3.90
Threadfin breams	5.01	Anchovies	3.49
Anchovies	4.92	Sciaenids	2.80
Silverbellies	3.58	Carangids	2.44
Lizard fishes	3.36	Goatfishes	2.42
Clupeoids	2.86	Crabs	2.32
Pomfrets	2.66	Lizard fishes	2.12
Crabs	2.33	Other finfishes and shellfishes	21.22
Barracudas	2.12		
Ribbon fishes	2.02		
Other finfishes and shellfishes	23.56		

Table 3. Share of different finfish/shellfish groups in motorised fishing in Andhra Pradesh (2017-20)

Group	Quantity share (%)	Group	Value share (%)
Penaeid shrimps	8.71	Penaeid shrimps	20.69
Catfishes	6.07	Snappers	6.38
Sciaenids	5.86	Catfishes	5.63
Horse mackerel	4.51	Eels	5.40
Ribbonfishes	4.44	Seer fishes	4.84
Snappers	4.37	Ribbon fishes	4.44
Crabs	4.31	Horse mackerel	4.05
Eels	3.92	Sciaenids	3.45
Indian mackerel	3.33	Indian mackerel	3.32
Seer fishes	3.23	Threadfin breams	3.14
Anchovies	3.15	Sharks	3.10
Threadfin breams	3.13	Pomfrets	2.81
Rays	3.13	Lizard fishes	2.76
Sharks	2.76	Grunters	2.41
Lizard fishes	2.72	Crabs	2.34
Silverbellies	2.31	Rays	2.20
Wolf herring	2.30	Lesser sardines	2.01
Other finfishes and shellfishes	29.81	Other finfishes and shellfishes	21.02

Table 4. Share of different finfish/shellfish groups in non-motorised fishing in Andhra Pradesh (2017-20)

Group	Quantity share (%)	Group	Value share (%)
Catfishes	8.59	Penaeid shrimps	12.02
Penaeid shrimps	5.63	Seer fishes	11.01
Indian mackerel	5.18	Catfishes	8.04
Snappers	4.83	Snappers	5.84
Seer fishes	4.82	Eels	5.76
Eels	4.56	Indian mackerel	5.29
Threadfin breams	4.09	Groupers	4.30
Horse mackerel	4.01	Threadfin breams	3.45
Sciaenids	3.47	Grunters	3.04
Wolf herring	3.46	Ribbon fishes	2.76
Groupers	3.45	Rays	2.65
Lizardfishes	3.33	Horse mackerel	2.47
Ribbonfishes	3.19	Wolf herring	2.30
Rays	3.13	Lizard fishes	2.29
Crabs	3.11	Sciaenids	2.18
Grunters	3.08	Tunas	2.06
Tardoore	2.92	Crabs	2.00
Anchovies	2.37	Other finfishes and shellfishes	22.54
Tunas	2.37		
Other finfishes and shellfishes	24.42		

operations from Trivandrum. Among motorised fishing operations, *Naravala* fishing method was found to be the best in terms of capital productivity, with *Jogavala* providing the least capital productivity. In an earlier study conducted by Venkata Raju *et al*. (2017) from the same area during 2003-2004, the average rate of return in non-motorised fishing operations was found to be superior when compared to motorised fishing operations.

Similar to Net Profit Margin, Return on Investment (ROI) was also highest (3.78 to 5.17) in non-motorised fishing operations, signifying it to be the best in terms of financial performance. For non-motorised fishing operations, the average cost of assets is very low as the crafts are manufactured using wooden logs, but motorised crafts are made up of fibre reinforced plastic (FRP) and hence, the asset cost is higher in motorised

Table 5. Economic performance of mechanised fishing operations (per trip) in Andhra Pradesh for the triennium 2017-2020

Component	Value
Crew wages (₹)	29,983 (12.75)
Crew bata, including food, stores and provisions (₹)	9,516 (4.05)
Sub-total labour cost (₹)	39,499(16.80)
Fuel cost (₹)	1,78,112 (75.76)
Auction charges (₹)	8,055 (3.43)
Other charges, including craft and gear repairs and maintenance (₹)	9,409 (4.00)
Sub-total input costs (₹)	1,95,576 (83.20)
Total operating cost (₹)	2,35,074(100.00)
Catch (kg)	3522
Gross revenue (₹)	3,90,346
Crew size (Number)	9
Net Cash Flow (₹)	1,55,272
Gross Profit (₹)	1,45,005
Net Profit Before Taxes (₹)	1,37,377
Net Profit Margin (%)	35.20
Return on Investment (ROI)	2.16
Capital Productivity (Operating ratio)	0.60
Labour Productivity (kg crew^{-1} trip^{-1})	391.30
Input-Output Ratio	0.50
Gross Value Added (₹)	1,94,770
GVA as a percent to Gross Revenue	49.90

Figures in parentheses indicate % to total operating cost

fishing operations. Motorised fishing operations, with the exception of *Naravala* (2.77) had low ROI. This could be attributed to the fact that Net Cash Flow and Gross Profit was low for other motorised fishing operations (*hook and line*, *Discovala* and *Jogavala*) and therefore, could be considered to be financially inferior. For mechanised fishing fleets in EU, more than 70% had ROI more than 7 (Carvalho *et al*., 2020), but in the present study, ROI of only 2.16 was observed in mechanised fishing operations. This could be attributed to the fact that EU mechanised fishing fleets were of industrial nature and were much longer with higher capacities, thus facilitating higher catch and returns when compared to the mechanised fleets in Andhra Pradesh.

Capital productivity was 0.6 for mechanised fishing operations, while for motorised and non-motorised fishing operations; it ranged from 0.54 to 0.60 and 0.54 to 0.59. 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 (0.50) for mechanised fishing operations, whereas for motorised and non-motorised fishing operations, it was pretty low. The values ranged from 0.09 to 0.19 for motorised fishing operations and for non-motorised fishing operations,

Table 6. Economic performance of motorised fishing operations (per trip) in Andhra Pradesh for the triennium 2017-2020

Component	*Hook and Line*	*Discovala*	*Jogavala*	*Naravala*
Crew wages (₹)	2035 (76.33)	3144 (74.29)	2562 (67.83)	6166 (84.20)
Crew bata, including food, stores and provisions (₹)	0	0	0	3 (0.04)
Sub-total labour cost (₹)	2035 (76.33)	3144 (74.29)	2562 (67.83)	6169 (84.24)
Fuel cost (₹)	597 (22.36)	1053 (24.86)	1179 (31.22)	872 (11.90)
Auction charges (₹)	0	0	0	47 (0.64)
Other charges, including craft and gear repairs and maintenance (₹)	35(1.31)	36(0.85)	36(0.95)	236(3.22)
Sub-total input costs (₹)	632(23.67)	1089 (25.71)	1215 (32.17)	1154 (15.76)
Total operating cost (₹)	2666(100)	4232(100)	3777(100)	7323(100)
Catch (kg)	29.3	36	40	127
Gross Revenue (₹)	4691	7376	6339	13489
Crew size (Number)	6	6	6	7
Net Cash Flow (₹)	2024	3144	2562	6165
Gross Profit (₹)	1898	3018	2436	6039
Net Profit Before Taxes (₹)	1838	2958	2376	5979
Net Profit Margin (%)	39.18	40.10	37.48	44.33
Return on Investment (ROI)	0.91	1.47	1.18	2.77
Capital Productivity (Operating Ratio)	0.57	0.57	0.60	0.54
Labour Productivity (kg crew^{-1} trip^{-1})	4.88	6.07	6.66	18.57
Input-Output Ratio	0.13	0.157	0.192	0.086
Gross Value Added (₹)	4059	6287	5124	12331
GVA as a per cent to Gross Revenue	86.53	85.23	80.83	91.41

Figures in parentheses indicate % to total operating cost

Table 7. Economic performance of non-motorised fishing operations (per trip) in Andhra Pradesh for the Triennium 2017-2020

Component	*Hook and line*	*Naravala*
Crew wages (₹)	3011(99.64)	4843 (98.72)
Crew bata, including food, stores and provisions (₹)	0	4 (0.08)
Sub-total labour cost (₹)	3011 (99.64)	4847(98.80)
Fuel cost (₹)	0	0
Auction charges (₹)	0	28 (0.57)
Other charges, including craft and gear repairs and maintenance (₹)	11 (0.36)	31(0.63)
Sub-total input costs (₹)	11(0.36)	59(1.20)
Total operating cost (₹)	3022(100)	4906(100)
Catch (kg)	29	100
Gross Revenue (₹)	5578	8382
Crew size (Number)	4	4
Net Cash Flow (₹)	2556	3476
Gross Profit (₹)	2513	3433
Net Profit Before Taxes (₹)	2493	3413
Net Profit Margin (%)	44.69	40.72
Return on Investment (ROI)	3.78	5.17
Capital Productivity (Operating Ratio)	0.54	0.59
Labour Productivity (kg crew^{-1} trip^{-1})	6.61	24.90
Input-Output Ratio	0.00	0.01
Gross Value Added (₹)	5567	8323
GVA as a per cent to Gross Revenue	99.80	99.29

Figures in parentheses indicate % to total operating cost

it was close to nil. With high fuel usage in multiday fishing operations, input costs accounted for 83.2% of the operational costs of mechanised fishing operations, hence, high Input-Output Ratio. On the contrary, in non-motorised fishing operations, input costs are very low (0.36 to 1.2%), 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-motorised 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 391.3 kg crew^{-1} trip^{-1}, as observed in the present study for mechanised fishing operations is far superior to 232 kg^{-1} crew^{-1} trip^{-1} recorded by Narayanakumar and Sathiadas (2005).

Maximum contribution to the economy in terms of cash or money was from mechanised fishing operations, as evident in high values of GVA. Among both, motorised and non-motorised fishing operations, *Naravala* provided the best returns to the economy with high amount of GVA, when compared to its counterparts. The share of the revenue that contributed to the economy was high for motorised and non-motorised fishing operations because of low input costs. The results of GVA to Gross Revenue are comparable to that of EU fleets (60%) (Carvalho *et al*., 2020).

The analysis of the economic performance indicated that more than 75% of the total operational cost in mechanised 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 benefit. Fuel should be made available at cheaper rates to the fishing networks to upgrade the productivity in mechanised units. In fishing tasks, the expanded expense of fishing per trip, the decreased catch and ensuing decrease in the gross revenue per trip have become significant imperatives influencing the monetary income from various fishing methods. The marine production from the inshore waters has reached its optimum and some resources are overexploited. Further increase in production from marine capture fisheries can only be achieved through judicious management of inshore fishery resources, through proper utilisation of harvested product using shore-based facilities, implementation of Code of Conduct for Responsible Fisheries (CCRF), participatory management and by diversifying to deep sea fishing operations.With high operating expenses incurred for most fishing operations, as evident from the financial indicators obtained in the present study, it is recommended to have budgetary provisions for monetary types of assistance by way of institutional finance at lower interest rates in the midst of hardships. This would be useful to eliminate the exploitation by money lenders who charge exorbitant rates for credit in the marine fishing sector, thereby, ensuring higher profitability for fishing operations. Fishing units with high factor productivity growth targeting high-value

resources improve fishing operations' efficacy and should be encouraged. Long liners targeting tuna and other high value fisheries must be pushed in order to increase net returns to fishermen and make fishing operations more attractive. The study recommends optimisation of resource use to improve the techno-economic efficiency of single day fishing operations (both motorised and non-motorised). With overcapacity existent in the mechanised fishing sector of Andhra Pradesh, the study suggests that a precautionary approach be followed for multi-day trawling.

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