The Seventh Indian Fisheries Forum Proceedings
Eds. C. Vasudevappa, Y. Basavaraju, D. Seenappa, S. Ayyappan & S. Ravichandra Reddy (2005)
Published by AFSIB Mangalore, ICAR, UAS(B), KVAFSU(B) & FFT(B) India

Techno Economic Efficiency of resource use in Trawl Fishing in Andhra Pradesh-A Case Study in Kakinada

R. Narayanakumar and R. Sathiadhas
Research Centre of Central Marine Fisheries Research Institute, Kakinada-533 004
Central Marine Fisheries Research Institute, Cochin-682 018

ABSTRACT

Fisheries sector in India has transformed from subsistence level to the status of an industry in the last five decades and contributes about 1.4 per cent to the country's GDP. Mechanization of fishing (mainly trawl fishing) is one of the factors responsible for this transformation. Presently about 47,000 mechanized crafts operate in the Indian Exclusive Economic Zone, harvesting the fishery resources in the inshore waters (0-50 m depth) and even beyond. In trawl fishing, the fishermen follow different fishing methods like multi-day or voyage fishing, lasting for about 5 to 12 days to get more catch and hence, income. These methods have not only brought higher catch but also caused the indiscriminate exploitation of commercially important fishery resources. This necessitates assessing the technical and economic efficiency of input use in trawl fishing to ascertain optimization of resource use, and hence the present study was carried out at Kakinada of East Godavari district of Andhra Pradesh.

The annual operating cost per trip worked out to Rs.4,175 for single day trawling and Rs.26,362 for multi-day trawling. The annual net operating income per trip of multi-day trawling was higher (Rs.17,185) than the single day trawling (Rs.6,664). However, the capital productivity was higher for a single day trawling (operating ratio of 0.39) than that of the multi-day trawling (0.62) The mean technical efficiency of single day trawling was 78.2 per cent and 65 per cent of the fishermen operated above the mean level. In case of multi-day trawling, the mean technical efficiency level was 94.5 per cent and 80 per cent of the fishermen operated between 90 and 100 per cent efficiency level. The study suggests that there is scope to improve the technical efficiency in single day fishing, by optimizing the resource use and also cautions to regulate multi-day trawling, which has already reached the near frontier level of production.

Keywords : Trawl fishing, efficiency, capital productivity, multiday trawling

INTRODUCTION

Fisheries sector plays a significant role in the Indian Economy, by serving as sources of income, employment, foreign exchange and food security for the people. The sector has transformed from a subsistence level of fishing to the status of a multi-crore industry through the last five decades. This transformation can be attributed to the technological developments in the areas of the harvesting, post-harvesting, processing and value addition. "India's share in global fish production has increased from 2.86 per cent (two million metric tones) in 1975 to 4.48 per cent (5.96 million metric tones) in 2002 and ranks third (2002) in the global fish production next to China and Peru. India's share in the global fish trade is 2.42 per cent, valued at US$ 1.41 billion (Bojan, 2005). Among the different technological developments, mechanization of fishing contributed significantly to the development of this sector. Presently, about 47,000 mechanized crafts are operating along the coast of India. The mechanized crafts

have been instrumental in harvesting the fishery resources in the inshore waters (0-50 m depth) and even beyond with the latest developments. Besides, fishers follow different fishing methods like multi-day or voyage fishing, lasting for about 5 to 12 days. While these crafts have helped the fishers to earn more money, they have also caused the indiscriminate exploitation of commercially important fishery resources (pushing them to near extinction), mainly driven by domestic and export demand. Under such a situation, there is a need to assess the technical and economic efficiency of resource use and their productivity in different fishing methods in general and trawl fishing (which accounts for about fifty per cent of the landings) in particular, to help the fishers to allocate the resources in an efficient manner in fishing. With this theme, the present study was carried out in Kakinada Fisheries Harbour of East Godavari district of Andhra Pradesh State.

Data and Methodology

Sampling Design

Andhra Pradesh State has nine coastal districts, out of which, East Godavari district was selected for this study. This district has the maximum proportion of trawlers operating from the State (59.09%) and contributes 32 per cent of the State's marine fish landings. The district has a coastal length of 161 km and a fisher population of 2,48,771, out of which 79,671(32.03%) are involved in marine fishing.

Kakinada Fisheries harbour is the major mechanized landing Centre in the district and one of the three major ports cum landing centres in Andhra Pradesh State and was selected for the Study. Ten sample units were selected for continuous data collection on operating costs and returns and also fixed cost details. The data was collected for one full year 2003-04 covering all the four quarters on four sample days selected using stratified random sampling methods.

The primary data was collected on operating costs per trip, which included the cost of fuel, crew wages, food expenses, auction charges and other miscellaneous charges. The data on the catch and species composition was collected to work out the revenue per trip.

Economic performance

The analysis of the economic performance of trawl fishing was done by working out the operating cost per trip, gross revenue per trip, net operating income per trip and annual net income through tabular analysis.

The operating cost per trip (also known as variable cost) is calculated as follows.

VC/trip = {(Fuel + Crew wage + Food + Auction + Other charges)}.....(1)

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

$$GR \text{ per trip} = \sum_{i=1}^{n} q_i p_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where, q_i is the quantity of catch in kg of the ith variety

p_i is the price per kg of fish of the ith variety

The details on the fixed cost, which includes the cost of the fishing equipments, insurance premium paid and related investment particulars were collected separately from the owners of the selected sample units. 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, which is taken at the rate of 18 per cent per annum. The capital and labour productivity were worked out using operating ratio and catch per labour per trip respectively. (Sathiadhas, 1996).

Efficiency measurement concepts

Farrell (1957) proposed that the efficiency of a firm consists of two components namely technical efficiency and allocative efficiency. The technical efficiency reflects the ability of the firm to obtain maximum output from a given set of inputs, while the allocative efficiency reflects the ability of the firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of total economic efficiency.

The efficiency of resource has been studied by many methods. The simple yield or return per unit or cost per unit has been used earlier in efficiency studies to compare the different firms or decision-making units. However these methods do not mention how much of the difference in efficiency is due to the amount of or ratio of inputs used and related effects.. Coelli (2002) highlighted the problems of using the simple measures for comparisons and also indicated that such measures do not tell anything about the existence or otherwise of scale economies. To avoid these problems he attempted constructing non-parametric production frontiers using data envelopment analysis (DEA) method.

In this study, the DEA method is applied to construct the production frontiers for Single day trawling and multi-day trawling separately and the levels of technical efficiency for these two operations were worked out. The analysis was done using the data envelopment analysis (computer) programme developed by Tim Coelli (1996).

RESULTS AND DISCUSSION

Economic performance

The economic performance of the trawling operations was analyzed estimating the annual cost and returns, net operating income, net income and other productivity measures.

The average initial investment on a mechanized trawler operating single day trawling worked out to Rs.5,66,650, while that of the craft operating a multi-day trawling worked out to Rs.6,65,700. The annual fixed cost comprising the depreciation and interest on fixed capital @ 15 per cent worked out to Rs.1,51,665 for a single day fishing (SDF) trawler and Rs.1,83,169 for a multi-day fishing (MDF) trawler.

The operating cost and returns per trip was worked out for each quarter for single day trawling and multi day trawling and presented in **Tables 1 and 2.**

It is seen that the average operating cost per trip ranged from Rs.3902 in July-September to Rs.4354 during January-March with an annual average of Rs.4175 per trip. The cost of fuel accounted for 60 per cent of the operating cost followed by crew wages (31.41%). The gross revenue per trip ranged form Rs.9753 during April-June to Rs.13,008 in July-September with an annual average of Rs.10,839. Penaeid prawns contributed 30-35 per cent in volume of the catch and 60-82 per cent in value of the catch.(**Table 3**). It is important to note that in Kakinada during 2003-04, crustaceans accounted for 35.8 per cent of the total landings and out of the crustaceans, prawns shared 59 per cent. Besides, the prawns' species diversity is very high in Kakinada, which adds to the revenue of the trawl fishing in this zone. It is also seen from the table that the annual net operating income worked out to Rs.6,664 and the operating ratio worked out

to 0.39. The average catch per trip was 257 kg with the average catch per labour at 42 kg.

It is seen from the **Table 2** that the operating cost per trip of multi day trawling (2-5 days) ranged from Rs.19783 in January-March to Rs.29,960 in April-June with an annual average of Rs.26,362. Fuel and crew wages accounted for about 96 per cent of the operating cost per trip. This is mainly due to the long distance traveled by the multi-day fishing units in search of potential fishing grounds and the average crew size, which ranges from 8-10 per trip. The gross revenue ranged from Rs.38,688 in October-December to Rs.48,942 during January-March with an average of Rs.43,546. Here also the prawns contributed about 16-28 per cent in terms of volume and 43-52 per cent in terms of value per trip. Besides, the catch of other varieties like mackerels, seer fish and pomfrets also contributed for the high revenue per trip. (**Table 4**). It is also seen from the table that the annual net operating income worked out to Rs.17,185 per trip with an operating ratio of 0.62. The operating ratio is higher for the multi day trawling, which indicate the high proportion of gross revenue required to meet the operating expenses per trip.

Table 1: Operating cost and returns per trip of the single day trawling in Kakinada 2003-04

Sl. No.	Details	April-June 2003	July-Sept. 2003	Oct-Dec. 2003	Jan-March 2004	Annual 2003-04
1	Fuel	2169 (50.61)	2084 (53.41)	2777 (66.80)	3021 (69.38)	2513 (60.19)
2	Crew Wages	1721 (40.16)	1422 (36.44)	1062 (25.55)	1040 (23.89)	1311 (31.41)
3	Food & Bata	279 (6.51)	306 (7.84)	228 (5.49)	156 (3.58)	242 (5.80)
4	Auction charges	56 (1.31)	30 (0.77)	30 (0.72)	77 (1.77)	48 (1.16)
5	Ice and salt	50 (1.17)	50 (1.28)	50 (1.28)	50 (1.15)	50 (1.20)
6	Others	10 (0.24)	10 (0.26)	10 (0.26)	10 (0.23)	10 (0.24)
7	Total Operating cost	4285 (100.0)	3892 (100.00)	4157 (100.0)	4354 (100.00)	4175 (100.00)
8	Gross revenue	9753	13008	10195	10399	10839
9	Operational surplus	5468	9116	6038	6045	6664
10	Operating ratio	0.44	0.30	0.41	0.42	0.39
11	Catch per trip	174	290	289	274	257
12	Catch/labour/trip	29	47	44	46	42

Table 2: Operating cost and returns per trip of multi-day trawling (2-5 days) in Kakinada 2003-04

Sl. No.	Details	April-June 2003	July-Sept. 2003	Oct-Dec. 2003	Jan-March 2004	Annual 2003-04
1	Fuel	17779	17128	20228	10211	16337
		(59.34)	(65.23)	(69.17)	(51.09)	(61.97)
2	Crew Wages	8476	5518	5547	7181	6681
		(28.29)	(21.02)	(18.97)	(35.93)	(25.34)
3	Food & Bata	657	112	131	83	246
		(2.19)	(0.43)	(0.45)	(0.42)	(0.93)
4	Auction charges	734	688	1088	931	860
		(2.45)	(2.62)	(3.72)	(4.66)	(3.26)
5	Ice and salt	2304	2800	2240	1571	2229
		(7.69)	(10.66)	(7.66)	(7.86)	(8.45)
6	Others	10(0.03)	10(0.04)	10(0.03)	10(0.05)	10(0.04)
7	Total Operating cost	29960	26426	29244	19783	26362
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
8	Gross revenue	46320	40235	38688	48942	43546
9	Operational surplus	16360	13989	9444	29159	17185
10	Operating ratio	0.65	0.65	0.86	0.40	0.62
11	Catch per trip	1471	1606	1048	2516	1660
12	Catch/labour/trip	210	229	131	359	232

Table 3 Catch composition of the single day trip in Kakinada, 2003-04

Species	April-June		July-September		October-Dec.		January-March	
	Qty.	Val.	Qty.	Val.	Qty.	Val.	Qty.	Val.
1. Oil sardines	0	0	3	9	7	64	0	0
	(0.00)	(0.00)	(0.97)	(0.07)	(2.56)	(0.63)	(0.00)	(0.00)
2. Ribbon fish	4	43	8	116	20	326	3	50
	(2.19)	(0.44)	(2.91)	(0.89)	(7.05)	(3.20)	(1.06)	(0.48)
3. Silver bellies	11	106	10	84	7	84	5	33
	(6.56)	(1.09)	(3.56)	(0.64)	(2.56)	(0.82)	(1.76)	(0.32)
4. Black Pomfrets	0	0	6	120	1	60	0	0
	(0.00)	(0.00)	(1.94)	(0.92)	(0.32)	(0.59)	(0.00)	(0.00)
5. White Pomfrets	2	74	3	131	3	225	0	0
	(1.09)	(0.76)	(0.97)	(1.01)	(0.97)	(2.21)	(0.00)	(0.00)
6. Mackerels	0	0	18	286	3	69	0	0
	(0.00)	(0.00)	(6.15)	(2.20)	(0.97)	(0.68)	(0.00)	(0.00)
7. Seer fish	0	0	6	272	2	90	0	0
	(0.00)	(0.00)	(1.94)	(2.09)	(0.64)	(0.88)	(0.00)	(0.00)
8. Croakers	15	308	26	367	5	68	5	62
	(8.74)	(3.16)	(9.06)	(2.82)	(1.60)	(0.67)	(1.76)	(0.61)
9. Peneaid prawns	57	7916	85	8246	99	6119	95	7041
	(32.79)	(81.16)	(29.45)	(6.39)	(34.29)	(60.02)	(34.51)	(67.71)
10. Crabs	3	94	27	566	13	483	5	90
	(1.64)	(0.96)	(9.39)	(4.35)	(4.49)	(4.74)	(1.74)	(0.87)
11. Others	82	1212	98	2811	129	2606	162	3122
	(46.99)	(12.42)	(33.66)	(21.61)	(44.55)	(25.57)	(59.15)	(30.02)
Total	174	9753	290	13008	289	10195	274	10399
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Note: Figures in parentheses indicate the percentage to the corresponding column total

Table 4: Catch composition of the multi-day trawling (2-5 days) in Kakinada, 2003-04

Species	April-June		July-September		October-Dec.		January-March	
	Qty.	Val.	Qty.	Val.	Qty.	Val.	Qty.	Val.
1. Sharks	4 (0.25)	470 (1.01)	13 (0.79)	391 (0.97)	5 (0.52)	189 (0.49)	15 (0.81)	552 (1.13)
2. Oil sardines	11 (0.71)	512 (1.10)	8 (0.49)	21 (0.05)	12 (1.13)	82 (0.21)	128 (6.89)	1163 (2.38)
3. Ribbon fish	8 (0.54)	382 (0.83)	74 (4.58)	726 (1.80)	99 (9.48)	1271 (3.31)	35 (1.88)	615 (1.66)
4. Silver bellies	7 (0.48)	237 (0.51)	28 (1.77)	219 (0.54)	29 (2.78)	173 (0.45)	38 (2.05)	262 (0.53)
5. Pomfrets Black	8 (0.52)	1412 (3.05)	34 (2.14)	767 (1.91)	9 (0.87)	327 (0.85)	20 (1.08)	815 (1.66)
6. Pomfrets-White	0 (0.00)	0 (0.00)	22 (1.34)	1131 (2.81)	36 (3.39)	2639 (6.87)	21 (1.13)	1695 (3.46)
7. Mackerels	44 (2.98)	3289 (7.10)	50 (3.11)	546 (1.30)	12 (1.13)	214 (0.56)	112 (6.03)	2697 (5.51)
8. Seer fish	3 (0.23)	430 (0.93)	19 (1.16)	523 (1.30)	5 (0.52)	235 (0.61)	17 0.92)	739 (1.51)
9. Croakers	16 (1.07)	1177 (2.54)	80 (5.01)	1329 (3.30)	64 (6.09)	1111 (2.89)	45 (2.42)	1056 (2.16)
10. Peneaid prawms	47 (3.20)	24160 (52.16)	270 (16.79)	21657 (53.83)	295 (28.17)	16787 (43.73)	266 (14.32)	20577 (42.04)
11. Crabs	4 (0.29)	459 (0.99)	59 (3.66)	1043 (2.59)	34 (3.22)	830 (2.16)	22 (1.18)	652 (1.33)
12.Others	1320 (89.73)	13791 (29.77)	942 (58.67)	11701 (29.08)	447 (42.70)	14530 (37.85)	1138 (61.28)	18119 **(37.02)**
Total	**1472 (100.00)**	**46319 (100.00)**	**1599 (100.00)**	**40054 (100.00)**	**1048 (100.00)**	**38388 (100.00)**	**1857 (100.00)**	**48942 (100.00)**

Note: Figures in parentheses indicate the percentage to the corresponding column total

Technical Efficiency

The technical efficiency was computed using the Data Envelopment Analysis (DEA) as formulated by Coelli (1996). The DEA is form of frontier function, which is used to estimate the efficiency of any practice or technology or innovative method. The input-oriented measure of technical efficiency was estimated with an assumption of Constant Returns to Scale using the DEA programme separately for single day trawling and multi-day trawling and the results are presented in **Tables 5 and 6.**

Table 5 Technical Efficiency for single day trawling in Kakinada, 2003-04

Efficiency Level	Frequency of the operators	Percentage
Less than 0.5	0	0.00
0.51 -0.60	3	9.37
0.61-0.70	8	25.00
0.71-0.80	7	21.88
0.81-0.90	8	25.00
0.91-1.00	6	18.75

Mean level of Efficiency =0.782 (or 78.2%)

It is seen that 72 per cent of the fishermen operate between 60 and 90 per cent efficiency level. It is also found that about 65 per cent of the fishermen operated above the mean efficiency level of 78.2 per cent. This indicated that still there is a scope to increase the efficiency in the SDF by 21.2 per cent.

operations. This analysis indicates that the MDF in trawling has a higher technical efficiency than the single day fishing. This may be due to the voyage fishing adopted by the MDF operators and the quantum of catch and its composition, which contains a higher proportion of high quality varieties like prawns, seer fishes, pomfrets and mackerels.

Table 6 Technical Efficiency for multi-day trawling in Kakinada, 2003-04

Efficiency Level	Frequency of the operators	Percentage
Less than 0.5	0	0.00
0.51 -0.60	0	0.00
0.61-0.70	0	0.00
0.71-0.80	1	2.78
0.81-0.90	6	16.67
0.91-1.00	29	80.55

Mean level of Efficiency =0.945 (or 94.5%)

It is seen that the multi-day fishing in trawling are operating at the highest technical efficiency of 94.5 per cent, which indicates that there is very little scope to increase the efficiency further as the technical inefficiency in the MDF is only 5.5 per cent (100-94.5). It is also found that 80 per cent of the fishers operate at an efficiency level of 80-90 per cent, which indicates the efficient nature of the MDF trawling

Conclusion and Policy Implications

Mechanization of fishing operations in India has contributed to a greater extent for the development of the sector, by lifting it up to the status of an industry from subsistence fishing in the pre-independence period. With new developments in the marine fishing operations, craft-gear combinations and methods of fishing

(single day and multi-day or voyage fishing), the fish landings and thus the income of the fishermen have increased gradually over a period of time. The relative economic performance of the different fishing methods has considerably improved as indicated by the productivity, profitability and financial feasibility of these fishing operations. In the present study also, the comparative assessment of the economic performance of the single day trawling and multi-day trawling indicated that the multi day trawling earned a higher annual net operating income of Rs.17,185 per trip against the single day trawling, which earned Rs.10,839 per trip. The high proportion of fuel input in both the cases have reduced the operational surplus and the net operating income-the magnitude of reduction is higher in multi-day trawling. Though both the operations are economically profitable, the input use or resource use efficiency in these two methods varied significantly. In case of the multi-day trawling, about 80 per cent of the fishermen operated at an efficiency level between 90 and 100 per cent, while the mean level of technical efficiency itself is 94.5 per cent. In case of the single day trawling, 72 per cent of the fishermen operate between 60 and 90 per cent efficiency level, while the mean technical efficiency level is 78.2 per cent. In this case about 65 per cent of the fishermen operate above the mean efficiency level. The study suggests that there is a scope to improve the technical efficiency in single day fishing to push it up to the frontier level, by optimizing the resource use and at the same time there is also a need to regulate the operation of the multi-day fishing, which has already reached the near frontier level of production. This will be one of the important steps to achieve long-term sustainable marine fish production and to maintain inter and intra generational equity in the use of marine fishery resources in the days to come.

REFERENCES

Bojan, J., 2005.Current scenario and growth prospects for fishery and raising India's share in global markets. Aqua International, 13(3): 26-32.

Coelli, T.J., 1996. A guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program. Centre for Efficiency and Productivity Analysis, University of New Englan, Armidale, New South Wales, Australia:1-49.

Coelli, T.J., Rahman, Sanzidur and Thirtle, Colin, 2002. Technical, allocative, cost and scale efficiencies in Bangladesh Rice Cultivation: A Non-parametric approach. Journal of Agricultural Economics, 53(3): 607-626.

Farrel, M.J., 1957. The measurement of productive efficiency. Journal of the Royal Statistical Society, Series A, CXX (Part3):253-290 (**Original not seen).**

Sathiadhas, R., 1996. Production and marketing management of marine fisheries in India. Daya Publishing House, New Delhi.