Current Journal of Applied Science and Technology

39(13): 89-93, 2020; Article no.CJAST.56865
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Economic and Environmental Implications of Trawl Fishing: An Analysis in *Munambam* Fishing Harbour on the South West Coast of India

N. Aswathy[1*] and R. Narayanakumar[2]

[1]ICAR-Central Marine Fisheries Research Institute, Kochi, Kerala, India.
[2]Madras Research Centre of ICAR-CMFRI, Chennai, Tamil Nadu, India.

Authors' contributions

This work carried out in collaboration between both the authors. Both authors read and approved final manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i1330684
Editor(s):
(1) Dr. Tushar Ranjan, Bihar Agricultural University, India.
Reviewers:
(1) Yves de Lafontaine, Canada.
(2) Vinay Kumar, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/56865

Original Research Article

Received 23 March 2020
Accepted 28 May 2020
Published 04 June 2020

ABSTRACT

Kerala state in the Southwest coast of India is an important maritime state and mechanized trawlers are the principal fishing units in the state. Since 2007, high speed engines were introduced in the trawl fishing sector which yielded higher hauling speed compared to the indigenous engines. Munambam fishing harbour is one of the biggest fishing harbours in Kerala where more than 90% of the mechanized trawlers operate with high speed engines. The high-speed trawlers were criticized for their environmental impacts to marine resources in terms of overexploitation and high fuel consumption. The fuel consumption of fishing units has economic, social and environmental implications with regard to sustainable fish harvests and livelihood security of fishermen. The objective of the study was to assess the economic and environmental implications of high speed trawl fishing units in Munambam fishing harbour on the South west coast of India. The data were collected from 90 boat operators from Munambam fishing harbour during the 2017-2018 fishing season. The samples were drawn randomly from the boat owners or boat operators. The results of the multiple regression analysis used to assess the factors affecting fish catches by high speed trawlers indicated that skipper's experience and fuel consumption had positive and significant

**Corresponding author: E-mail: aswathysaji@rediffmail.com, aswathy.icar@gmail.com;*

influence on fish catch and 1% increase in quantity of fuel used led to an increase of 0.363% in gross income. The carbon dioxide emissions from the trawlers were also estimated to assess the environmental implications.

Keywords: Economic indicators; high speed trawlers; resource use efficiency.

1. INTRODUCTION

Fuel consumption by fishing vessels is the primary source of greenhouse gas emissions in the marine fishing industry [1]. The CO_2 released into the atmosphere by marine fishing vessels around the world in 2016 was estimated at 207 million tones [2]. There was substantial increase in fuel consumption in the global fishing fleet with advanced fishing technologies targeting the marine catches. Fuel consumption by fishing vessels has substantial environmental, economic, and social implications with regard to fishing operations, products and supply chains, and the viability and resilience of fishing communities [3].

The state of Kerala in the South west coast of India had an average marine fish landings of 0.6 million tonnes per year, representing 16% of the total marine fish landings in the country. Fish catches by mechanized trawlers, the main fishing units in the state, declined from 0.27 million tonnes in 1997 to 0.21 million tonnes in 2015, a 22% reduction in less than 20 years. The catch per unit effort of multiday trawlers declined from 1.15 tonnes in 1997-2006 to 1.13 tonnes in 2007-15 [4]. High speed engines with 270 HP horsepower imported largely from China in 2007 helped to increase the towing speed for catching fast moving fishes. The vessels equipped with such engines were capable of trawling from the bottom to the surface, at a speed of 2.5 to 4.5 nautical miles per hour, while other boats trawl the bottom at speed lesser than 2.5 nautical miles per hour. The high-powered engines enable the vessels to carry out mid-water trawling and pelagic (surface) trawling as well. The trawling capacity was further increased with the introduction of new engines reaching 550 HP in 2018. The high speed engines became popular among the boat operators as they enabled the use of large nets and rapid movement at sea. In Kerala state out of the total number of 3678 trawlers, 28% belonged to Ernakulam District. A total of 350 trawlers operate in Munambam fishing harbor [5], with more than 90% of these trawlers equipped with high speed engines. This harbor was therefore selected for the present study which examined the fuel use efficiency of trawlers equipped with high speed engines. The environmental impacts in terms of carbon dioxide emissions were also estimated based on the average fuel consumption requirements.

The profitability of trawl fishery was analysed by various authors in different parts of the world. Tietze et al. [6] Aswathy et al. [7] in Kerala, Narayankumar et al. [8] Geetha et al. [9] in Tamil Nadu, Renju Revi et al. [10] in Kerala etc. Multiple regression analysis was used in several studies to assess the economic efficiency of marine fishing units [11]. Effiong and Eke [12] in Nigeria; Kalidhos et al. [13] and Najmudeen and Sathiadhas [14] in Kerala state, India.

2. MATERIALS AND METHODS

The fuel use efficiency of Chinese engines in the marine fishing sector of Kerala was analyzed by collecting data from 90 trawlers operating in Munambam fishing harbour in Kerala during the 2017-2018 fishing period. The economic performance of these fishing units were analyzed by collecting data on general characteristics of the vessels, engine details, modifications/ replacements done for introducing the new engines, operating expenses and revenues per fishing trip. The following standard economic performance indicators were used to assess the economic performance:

Gross profit (GP) = Gross revenue less direct fishing costs, indicating the short-term economic viability of the fisheries operation [15]. The fishing costs consisted of costs of fuel, ice, labour, auction charges, water charges, landing charges and other miscellaneous expenses. The labour costs consisted of crew share and crew bata. The crew share was calculated as 35% of the gross profit after deducting all operational expenses from gross revenue. The crew bata is the fixed amount of payment paid per day to the crew members irrespective of the gross earnings received in each fishing trip.

Net profit= Gross Profit - (Depreciation + Interest on fixed capital)

Input-Output Ratio= Input cost/ Gross revenue

Operating ratio= Operating costs/ Gross revenue

Operating ratio measures the operational efficiency (or the capital productivity) of the fishing enterprise

Net benefit earnings ratio = Net Cash Flow (NCF)/Total Earnings (TE)

The ratio expresses the NCF or net benefit as a percentage of TE. A ratio of more than 10% can be considered as good. The NCF or net profit expressed as a percentage of the invested capital indicates the profitability of the investment in relation to other alternative investments. A level of 10 percent is generally viewed to be good.

Multiple regression analysis was employed to assess and determine the factors affecting fisheries production (or fish catches).Several economic, technical and managerial variables do affect marine fisheries production. The major variable input factors which affect the fisheries production consist of fuel, labour, ice etc. The technical inputs such as capacity of the boat, gears and engines can also influence the volume of the catch. Among the managerial variables, selection of fishing grounds, the experience of the skipper and duration of fishing affects fish catch. The following variables were therefore selected to assess the factors affecting fisheries production.

P = F (OL, DF, EX, FL, IC, LB)

Where P = Gross catch per fishing trip (kg)
OL = Overall length (OAL) of the fishing boat (meters)
DF = Number of days of fishing per fishing trip
EX = Experience of the skipper (years)
FL=Fuel consumed per trip (litres)
IC=Weight of Ice used per trip (kg)
LB=Labour(number of workers in a boat)

The carbon dioxide emissions of the high speed trawl fishing sector were also estimated by converting the average diesel consumption of the boats into equivalent carbon dioxide emissions. The approximate CO_2 emission from fuel (diesel)was taken as 2.675 kg of CO_2 based on the standard conversion factor that 1 l of fuel (diesel) produces 10.7 kWh of heat, and the CO_2 emitted from 1 kWh is 0.25 kg respectively [16, 17].

3. RESULTS AND DISCUSSION

All the sampled boats in the selected fishing harbour were equipped with high speed engines imported from China, the prominent types in operation being Weichai, Sinotruck and Shanghai. The horsepower of the engines of the sampled trawlers varied from 250-500 HP. The average length of boat was 72 m with investment cost of 102,857 USD including hull, gears and engine.

Profitability indicators of high speed trawlers showed that the net profit per trip was 2,120 USD with operating ratio of 0.69 and input output ratio of 0.24. The fuel cost accounted 56% of the total operational expenses. These results are in conformity with the economic indicators of the trawl fishery of Neendakara - Shakthikulangara belt of Kollam district in Kerala state showing that the capital productivity ratio was 0.76 for the single day operating trawlers and 0.86 for the multiday trawlers [18].

Results from the multiple regression analysis used to assess the resource use efficiency of high speed trawlers revealed that, the Cobb-Douglas production function with the variables overall length, days of fishing, experience of skipper and fuel quantity showed the best fit among the different models tested.

Experience of the skipper and fuel consumption had positive and significant influence on fish catch. A 1% change in experience of the skipper increased gross income by 0.904% and a 1% increase in quantity of fuel used increased gross income by 0.363%. The results did correspond to those of an economic efficiency analysis of trawlers conducted in 2005 in Kerala state which indicated that number of fishing days per unit and the quantity of fuel used in a year were significant factors contributing to fish production by trawlers in Kerala [14]. Analysis of the factors which affect the income of fishermen in Lhokseumawe, Indonesia using log linear regression model showed that working capital, labour, work experience, and technology had a significant and positive influence on fisherman's income in Lhokseumawe. Analysis of economic performance of marine fishing crafts in Thoothukudi province of Tamil Nadu using multiple regression analysis indicated that labour wages, annual fishing days and fuel influenced the fish catch [13].

Table 1. General characteristics of high speed trawlers

Items of cost	High speed trawlers
Days of fishing	9
Fuel consumption/ trip(l)	3521
Overall length(m)	72
Catch (kg)	3560
Experience of the skipper(years)	16

Table 2. Economic indicators of trawlers with high speed engines

Economic indicators	Value/ fishing trip
Total operating cost (USD)	6020
Gross revenue (USD)	8725
Fixed cost/ trip (USD)	585
Total cost (USD)	6605
Net profit (USD)	2120
Net operating income (USD)	2705
Capital productivity ratio	0.69
Net -Benefit Earnings ratio	0.24
Input-output ratio	0.48

Table 3. Resource use efficiency of high-speed trawlers in Kerala

Variables	B	Std error	T	Level of Significance
Constant	4.606**	1.358	3.392	.001
Days of fishing	-.125	.179	-.696	.489
Experience of skipper(years)	.904**	.139	6.490	.000
Fuel Consumption(l)	.363**	.106	3.424	.001
Overall length (m)	-.401	.316	-1.271	.207

*Note: ** indicates significance at 1% level*

Table 4. Estimated CO_2 emissions by the high speed trawlers in Munambam harbour

Particulars	Values
Total no of high-speed trawlers	315
Annual fishing trips/unit	30
Average diesel consumption/ trip(l)	3521
CO_2 emissions(t)	89006

The annual CO_2 emissions by the high speed trawlers in Munambam harbour was estimated to be 89,006 ton the basis of atleast 30 fishing trips undertaken by the high speed trawlers (Table 4). The exponential growth in engine horsepower of the high speed trawlers above 18 m in length in recent years points out the need for regulating capacities of the fishing vessels in order to conserve fuel and reduce greenhouse gas (GHG) emissions [10].

4. CONCLUSION

The analysis showed that 1% increase in the quantity of fuel used by high-speed engines increased fish catch by 0.363%, which implies that increase in fuel consumption resulted in less than proportionate increase in fish catch. There was a consistent rise in marine fish prices in Kerala in recent years with significant decline in fish catch. Since the growth in diesel price has surpassed the average growth in fish prices, the increased fuel cost will certainly increase the fishing costs without commensurate increase in gross earnings from fishing. The analysis indicated that there is an overuse of diesel in the trawl fishing which will ultimately have serious repercussions on the fish production and sustainability of trawler operations. The increased fuel use will also have serious impacts on the environment in terms of increased greenhouse gas emissions. Hence we recommend that it is highly imperative to reduce the fuel use either by regulating the capacities of fishing units or by adopting more efficient fishing techniques to reduce fuel consumption.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Muir JF. Fuel and energy use in the fisheries sector – approaches, inventories and strategic implications, FAO Fisheries and Aquaculture Circular No. 1080. Rome, Italy; 2015.
2. Krista Greer, Dirk Zeller, Jessika Woroniak, Angie Coulter, Maeve Winchester ML, Deng Palomares, Daniel Pauly. Global trends in carbon dioxide (co_2) emissions from fuel combustion in marine fisheries from 1950 to 2016, Mar policy. 2019;107.
3. Tyedmers PH. Reg Watson and Daniel Pauly. Fueling Global Fishing Fleets, Ambio. 2005;34(8):635-638.
4. Aswathy N, Narayana Kumar R, SomyKuriakose, Rekha J Nair. Total factor productivity growth of trawl fishing in Kerala state, India, Int J Fish Aquat Stud. 2018;6(2):633-636.
5. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi. Marine Fisheries Census 2010 Part I India. CMFRI, Kochi; 2012.
6. Tietze U, Thiele W, Lasch R, Thomsen B, Rihan D. Economic performance and fishing efficiency of marine capture fisheries. FAO Fisheries Technical Paper. No. 482. Rome, FAO; 2005.
7. Aswathy N, Shanmugam TR, Sathiadhas R. Economic viability of mechanized fishing units and socio-economics of fishing ban in Kerala. Indian J Fish. 2011; 58(2):115-120.
8. Narayanakumar R, Sathiadhas R, Aswathy N. Economic performance of marine fishing methods in India. Marine Fisheries Information Service, Technical and Extension Series. 2009;200:3-16.
9. Geetha R, Narayanakumar R, Shyam S Salim, Aswathy N, Chandrasekar S, Srinivasa Raghavan V et al. Economic efficiency of mechanised fishing in Tamil Nadu – A case study in Chennai. Indian J Fish. 2014;61(4):31-35.
10. Renju Ravi, Vipin PM, Boopendranath MR, Joshy CG, Leela Edwin. Structural changes in the mechanized fishing fleet of Kerala, South India, Indian J Fish. 2014; 61(2):1-6.
11. Almeida OT, McGrath D, Arima E, Ruffino ML. Production analysis of commercial fishing in the Lower Amazon. In: Dolsak N, Ostrom E, editors. Constituting the Commons: Crafting Sustainable Commons in the New Millennium. Proceedings of the 8th Conference of the International Association for the Study of Common Property. Bloomington, University of Indiana; 2000.
12. Effiong JAL, Eke IC. Factors affecting earnings of trawling vessels in Nigeria**.** Int J Advanced Academic Res Sci Technology & Engineering. 2016;2(4). [ISSN: 2488-9849]
13. Kalidhos Radhakrishnan, Prakash S, Narayanakumar R, Krishnan M, Madan MS, Kumar NR. Economic performance of marine fishing crafts in Thoothukudi province of Tamil Nadu. Indian J Geomarine Sci. 2018;47(3):653-659.
14. Najmudeen TM, Sathiadhas R. Economic efficiency of input utilization of mechanized trawlers along the Kerala coast, J Mar Biol Ass India. 2007;49(2):113-117.
15. Tietze U, Prado J, Lery JM, Lasch R. Techno-economic performance of marine capture fisheries. FAO Fisheries Technical Paper 421, Rome; 2001.
16. Ghosh S, Hanumantha Rao MV, Sathishkumar M, Uma Mahesh V, Muktha M, Zakharia PU. Carbon footprint of marine fisheries: Life Cycle analysis from Visakhapatanam. Current Science. 2014; 107(3):515-521.
17. Energy and carbon conversions. Carbon Trust, United Kingdom, Available:www.thecarbontrust.co.uk/energy
18. Femeena Hassan, R. Sathiadhas. An appraisal of trawl fishery of Kerala. Asian Fish Sci. 2009;22:277-284.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/56865