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Assessment of Fuel Consumption Rate of Mechanised Trawlers in Kerala, South India

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ABSTRACT

Globally,fisheries production is facing concerns in the form of sustainability issues, increased fuel consumption and resultant burdens contribute to worsen the scenario. All specified concerns are most prominent in trawling industry which is the most common and dominating worldwide. As India is dependent deeply on fisheries for employment and food security, the energy cost is a concern among seafood consumers, seafood traders and fishing communities. Rate of average fuel consumption of mechanised trawl fishing fleet of Kerala in a year is estimated. Rate of fuel consumption found to be higher in very large trawlers and lower in small trawlers. While comparing single-day trawlers found to be consuming 57% lesser fuel than multiday trawlers. If small trawlers are taken as a base, the rate of fuel consumption is 18.5% higher in medium trawlers, 74% higher in large trawlers and 180% higher in very large trawlers. The average annual fuel consumption of is highest in very large trawlers followed by large trawlers, medium trawlers, small trawlers (multi-day) and small trawlers (single-day).

Keywords: Mechanized trawler, L_{OA}, Fuel consumption, Kerala

Mechanised fishing is an energy intensive method of food production which consumes 15-20 times more energy than it produces (Endal, 1989). It is exclusively depending on fossil fuel which is limited and non-renewable. Most of the environmental concerns mankind faces can be connected to energy use especially fossil fuels in one way or other. Fossil fuel release carbon dioxide and other greenhouse gases to the atmosphere which leads to the phenomenon, 'greenhouse gas effect' and its concomitant impacts make changes in climate, sea level rise and global warming. Fossil fuels are also responsible for production of pollutants such as suspended particulate matter, photochemical smog particulates, ozone-depleting substances like CFCs and gaseous emissions such as sulphur dioxide (SO_2), carbon monoxide (CO) and oxides of nitrogen, which are injurious to the environment and human health (TERI, 1999; Pelletier *et al.* 2007; Avadi & Freon, 2013 and Parker & Tyedmers, 2015). Because of all the specified concerns fuel use can be the key to determine the environmental sustainability of a fishery activity. Carbon emission from fisheries is based on two aspects primarily as a waste of fossil fuel combustion and secondarily as provision of craft, gear, engine, fuel, ice and other necessities (Ziegler *et al.* 2003; Hospido & Tyedmers, 2005 & Thrane, 2006). Fuel consumption is a factor which heavily depend on various factors among which type of fishing method employed is predominant

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(Boopendranath, 2008; Thrane, 2004; Tyedmers *et al.* 2005; FAO, 2007; Schau *et al.* 2009; Cheilari *et al.* 2013; Parker & Tyedmers, 2015; Parker *et al.* 2015; Wiviott & Mathews, 1975; Leach, 1976; Edwardson, 1976; Lorentzen, 1978; Rawitscher, 1978; Nomura, 1980; Hopper, 1982; Watanabe & Okubo, 1989 and Tyedmers, 2001). Purse seining and trawling are the most common fishing methods (Sainsbury, 1971) among which trawling found to be 15 times more energy intensive than purse seining. Not only in comparison with purse seining, trawling found to be more energy intensive when compared to any other fishing methods whether it is active or passive (Wiviott & Mathews, 1975; Leach, 1976; Edwardson, 1976; Lorentzen, 1978; Rawitscher, 1978; Nomura, 1980; Hopper, 1982; Watanabe & Okubo, 1989 and Tyedmers, 2001). In addition to the type of fishing method employed, amount of fuel consumption may vary depending on the size and design of the vessel and engine, weather conditions, type and size of fishing gears, location, skill and knowledge of the crew among which vessel size have a major role (Wiviott& Mathews, 1975; Rochereau, 1976; Edwardson, 1976; Lorentzen, 1978; Watanabe & Okubo, 1989).

Fuel consumption of a given fishery even within a local area can change as the abundance of fisheries resources change, fleets expand, average size of vessels increase, vessels travel further to fish and become more technologically advanced. Rising fuel price in association with the future scarcity of fossil fuels and increased environmental hazards have raised the awareness on fuel efficiency of fishery sector.

MATERIALS AND METHODS

The study was conducted among 40 selected trawlers operated form Munambam and Cochin harbours of Ernakulam district of Kerala. Data regarding fuel consumption of each trip of selected trawlers were collected for continuous two years from June, 2014 to May, 2016. The data was collected using pretested questionnaire, which administered to the engine driver of the trawlers and were collected back after their arrival. Annual fuel consumption of trawlers was estimated as the sum of fuel consumption per trip for whole year and the average of two years.

RESULTS AND DISCUSSION

Fuel consumption varies considerably based on the size of trawlers and duration of their operation. Hence, fuel consumption per vessel has been estimated separately for different length class of trawlers. In Kerala, both single-day and multi-day trawlers exist in which single-day trawlers constitute only 5% of the total trawl fishing fleet and remaining 95% are multi-day trawlers with a maximum duration of 15 days. Fuel consumption in terms of fuel consumption per trip, fuel consumption per day, fuel consumption per hour and annual fuel consumption in litres of five types of trawlers were estimated (Table 1).

Fuel consumption in mechanised trawlers

Single-day trawlers

In Kerala exclusively small trawlers with L_{OA} 10-12m are conducting single-day fishing at present,

Table 1: Profile of fuel consumption (litres) of mechanised trawlers in Kerala

Specification	Small trawlers (single-day)	Small trawlers (multi-day)	Medium trawlers	Large trawlers	Very large trawlers
Fuel consumption per hour	6.12 - 8.75 (7.5)	15.3 - 18.9 (17.3)	17 – 23 (20.45)	26.7 – 32.3 (30.1)	43.86 – 52.8 (48.5)
Fuel consumption per day	49 – 70 (60)	138 – 170 (155.7165)	190 – 244 (225.0)	320.66–387.73 (361.07)	526.37 - 633.62 (582.27)
Fuel consumption per trip	—	414 – 510 (467)	948.5– 1219.5 (1125)	3207 – 3877 (3610)	6735 – 7345 (6987)
Fuel consumption per year	11760 – 12312 (12036)	34095 – 36085 (35090.3)	46287 – 60243 (54722.0)	86438 – 97675 (90285)	140589 – 153246 (146732.5)

Note: Averages are shown in parenthesis.

from November to May. Annual fuel consumption of trawlers was estimated as sum of the fuel consumption of all trips in a year from November to May. The average annual fuel consumption of small trawlers (single-day) was estimated to be 12036 litres per vessel with a range of 11760 to 12312 litres. During the study period, fuel consumption per day varied from 49 to 70 litres and the average was estimated as 60 litres. Ravi (2015) also reported the same. Average fuel consumption per hour can be calculated as 7.5 litres with a range of 6.12 to 8.75 litres.

Multi-day trawlers

Multi-day trawlers operate whole year except trawl ban period, hence it can be said that on an average they conduct fishing for 10 months in a year. These trawlers target finfish, shrimps and cephalopods depending on the season and availability of resources.

Small trawlers

Small trawlers constructed with steel and powered with 240-350 hp imported engines conduct multi-day operations. Fuel consumption per trip of small trawlers (multi-day) varied from 414.0 to 510.0 litres and on an average it can be estimated as 468.0 litres. Annual fuel consumption of small trawlers (multi-day) ranged from 34095 to 36085 litres with an average of 35090 litres per vessel (Table 1). Fuel consumption per day varied from 138 to 170 litres and the average was estimated to be 156.0 litres. Average fuel consumption per trip was estimated to be 1125.0 litres.

Medium trawlers

Medium trawlers are found to conduct only multi-day fishing extending from 3 to 10 days. In the present study, fuel consumption per tip of medium trawlers varied from 949.0 – 1220.0 litres and average fuel consumption per trip was estimated to be 1125.0 litres. Fuel consumption per day varied from 190.0 to 244.0 litres in these trawlers and the average was estimated at 225.0 litres. Average fuel consumption per hour was estimated as 20.45 litres with a range of 17.25 to 22.17 litres. Ravi (2015) has reported the fuel consumption of medium trawlers as 192 to 540 litres in a day. During 2007, fuel consumption per day of trawlers with L_{OA} less than 16.0 m was reported as 100 to 200 litres which came upto 500 to 1000 litres per trip depending on the duration of the trip (Aswathy *et al.* 2011). Average annual fuel consumption of medium trawlers in the state at present is 54722 litres per vessel which ranged from 46287 to 60243 litres.

Large trawlers

Large trawlers have L_{OA} between 16.0 and 24.0 m and conduct multi-day fishing for whole year. Fuel consumption per trip of these trawlers varied from 3207 to 3877 litres and the average fuel consumption per trip can be estimated as 3610 litres. Annual fuel consumption of these trawlers ranged from 86438 to 97675 litres. On an average annual fuel consumption of large trawlers was estimated to be 90285 litres per vessel. Average fuel consumption per day can be estimated as 361.07 litres with a range of 320.66 to 387.73 litres. Average fuel consumption per hour of large trawlers was estimated as 30 litres which ranged from 26.7 to 32.3 litres. Large mechanised trawlers having L_{OA} more than 16.0 m are reported to consume 250 – 300 litre of fuel per day and 1000 – 2000 litre of fuel per trip (Aswathy *et al.* 2011).

Very large trawlers

Fuel consumption of very large trawlers (L_{OA} more than 24.0 m) varied from 6735 to 7345 litres per trip with an average of 6987 litres per vessel. Annual fuel consumption of these trawlers varied from 140589 to 153246 litres and the average was estimated as 146732 litres in a year. Ravi (2015) has also quantified the annual fuel consumption of very large trawlers between 103680 and 151200 litres. Fuel consumption per day of these categories of trawlers varied from 526.37 to 633.62 litres at present and the average was estimated to be 582.27 litres. Average fuel consumption per hour was calculated as 48.5 litres which ranged from 43.86 to 52.8 litres.

According to the present study, both single-day and multi-day trawlers are operated in Kerala; single-day trawlers constitute only 5% and remaining 95% are multiday trawlers. A comparison of fuel consumption of different length class of trawlers was depicted graphically. Through the present study, it is understood that rate of fuel consumption was highest in very large trawlers (Fig. 1), followed by large trawlers, medium trawlers, small trawlers (multi-day) and small trawlers (single-day).

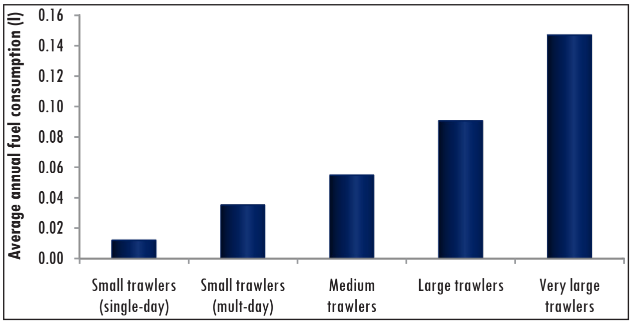

Fig. 1: Average annual fuel consumption of mechanised trawlers of Kerala

A general comparison of fuel consumption between trawlers is not relevant because of the variation in factors influencing fuel consumption. Hence fuel consumption per day and fuel consumption per hour are used to compare the fuel consumption between trawlers. To understand the difference in fuel consumption between single-day and multi-day operations, a comparison of small trawlers (single-day) and small trawlers (multi-day) is depicted. Fuel consumption per day of single-day trawlers was 60 litres and that of multi-day trawlers was 156 litres, accordingly single-day operations consume 62% less fuel than multi-day operations (Fig. 2).

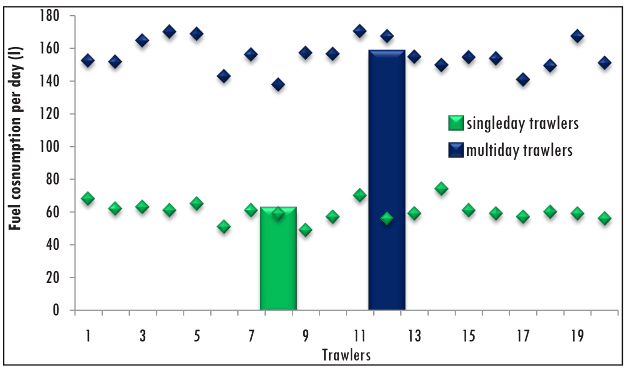

Fig. 2: Comparison of fuel consumption per day of single-day and multi-day trawlers (small trawlers)

But there was a significant variation in duration of operation in a day, i.e. 8 hours for single-day trawlers and 9 hours for multi-day trawlers. Hence a comparison of fuel consumption per hour will be more accurate. The average fuel consumption per hour of single-day trawlers was 7.5 litres and that of multi-day trawlers was 17.3 litre (Fig. 3).

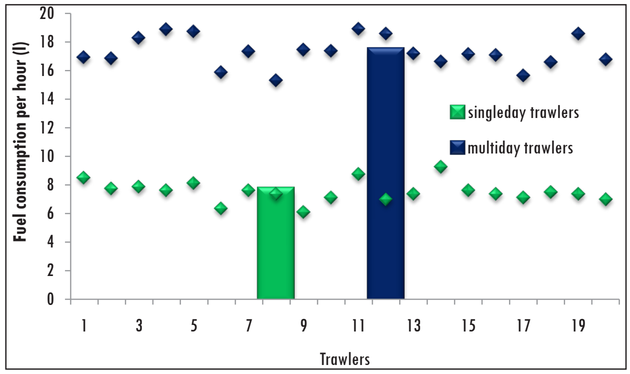

Fig. 3: Comparison of fuel consumption per hour of single-day and multi-day trawlers (small trawlers)

Hence it can be concluded that single-day trawlers consume 57% less fuel compared to multiday trawlers. Major reason behind this variation is the make of engine and its power used by the trawlers. The horsepower of engine used by single-day trawlers ranged from 116- 240 hp but for multiday trawlers it was 240-350 hp.

Among multiday trawlers, fuel consumption found to be increasing with the size of trawlers and engine power. Rate of fuel consumption was higher in very large trawlers, followed by large trawlers, medium trawlers and small trawlers. Fuel consumption per day was 582 litres in very large trawlers, 361 litres in large trawlers, 225 litres in medium trawlers and 156 litres in small trawlers (Fig. 4).

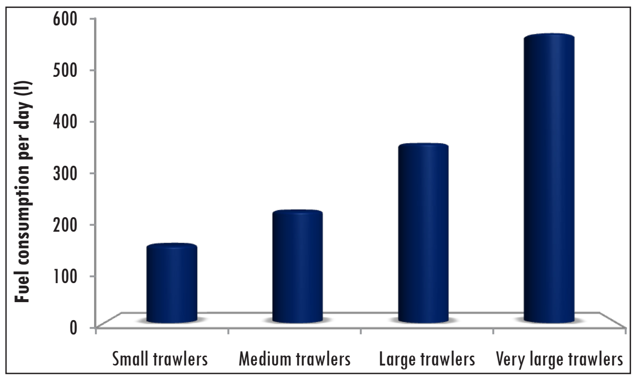

Fig. 4: Average fuel consumtpion per day of multi-day mechanised tarwlers

Since there was a variation in duration of operation in a day, fuel consumption per hour can be taken as the measure to compare the rate of fuel consumption between different length classes of trawlers. It was 48.5 litres in very large trawlers, 30 litre for large trawlers, 20.5 litres for medium trawlers and 17.3 litres for small trawlers (Fig. 5).

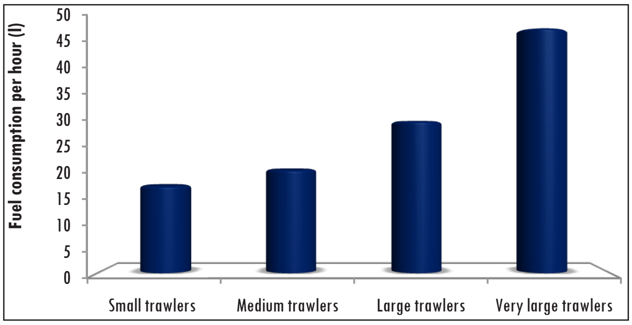

Fig. 5: Average fuel consumption per hour of mechanised trawlers

Variation in fuel consumption per hour of different length class of trawlers was statistically confirmed using t test which was significant ($p<0.00$). If small trawlers are taken as a base to compare the rate of fuel consumption among multiday trawlers, it was 18.5% higher in medium trawlers, 74% higher in large trawlers and 180% higher in very large trawlers.

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