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Energy Analysis of Mini-trawl Operations, off Cochin, Kerala, India

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Abstract

Mini-trawls are towed gear consisting of funnel shaped body of netting closed by a bag or codend and extended sides in the front to form wings. They are usually operated from a single vessel, using a pair of small otter boards as horizontal spreading device. Fish production and energy requirement in the mini-trawl operations, off Cochin, Kerala, India are discussed in this paper. Mini-trawling is generally targeted at coastal prawn resources, particularly *Parapenaeopsis stylifera* and *Metapenaeus dobsoni*. Mean catch per year per mini-trawler during the period of study (1997-98) was 10.26 t, 48.1% of which was constituted by prawns, followed by flat fishes (33.1%), crabs (12.0%) and miscellaneous finfishes (6.8%). Total embodied energy inputs into mini-trawler operation was estimated to be 207.04 GJ and the energy equivalent of fish produced was 38.62 GJ. The GER t fish^{-1} for mini-trawling was estimated to be 20.2 GJ, which is quite high for a coastal fishing operation. Kerosene constituted 86.24% of the GER, followed by petrol (8.39%), lubricating oil (3.30%), fishing gear (1.4%), outboard motor (0.58%) and fishing craft (0.06%). Energy ratio for mini-trawling was 0.19 and energy intensity 5.36. The mini-trawl operations in the coastal waters need to be strictly regulated in view of the high GER and predominance juveniles in the landings and the implied negative impacts on environment and resources.

Keywords: Mini-trawl; fish production; Gross Energy Requirement

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Introduction

The introduction of outboard motors in coastal fisheries has transformed the face of traditional fishing activities and has brought about changes in the existing crafts and gears operated in this sector. One of the significant outcome is the facility to drag a mini version of trawl net from the small traditional craft which was modified with transom to facilitate the fitting of an outboard motor. The mini trawl is usually operated from a single vessel, using a pair of small otter boards as horizontal spreading device.

Tulay & Smith (1982) and Dickson (2001) have reported on the mini trawl or "baby trawl" operations in the San Miguel Bay in the Philippines. Hameed et al. (1989) described the design, operation and economic performance of mini-trawls, operated from Cochin and Munambam, during 1987-88. Girijavallabhan (1994) reported a form of mini-trawl operation along south Malabar coast, which was conducted using two traditional motorised boats without using otter boards (pair trawling). Vijayan et al. (1990) developed an improved mini-trawl design suitable for traditional motorised crafts, based on comparative fishing trials. Mini-trawl fishery of Kerala has been discussed by Ammini et al. (2004) and Nandakumar et al. (2005). Remesan & Ramachandran (2005) has described mini-trawls with head rope length of 3.5-8 m rigged with 6-7 kg flat rectangular wooden otter boards operated from non-motorised wooden canoes (4-5 m L_{OA}) in the estuarine areas in Kasargod, Kerala, for harvesting shrimps, crabs and finfishes

The number of mini-trawl gears in Kerala, during 1991 was estimated to be 1648 (SIFFS, 1992). Their number rose to 4351 in 1998 (SIFFS, 1999), registering an average annual growth rate of 27.3% Mini-trawls are operated from plank canoes and plywood boats fitted with outboard engines, in the coastal waters. Plank-built canoes with transom are the dominant craft used for mini-trawl operations in

Alappuzha, Thrissur and Ernakulam. Average contribution of mini-trawls to the total marine landings of Kerala, during 1997-2005, has been about 12744 t which formed 2.5 % of the total landings (Kurup et al., 2009). Gross Energy Requirement (GER) is the sum of all non-renewable energy resources consumed in making available a product or service. GER is a measure of intensity of non-renewable resource use (Slesser, 1988). Energy ratio or Energy efficiency ratio is the ratio between metabolizable energy produced and the amount of non-renewable energy consumed (energy output / energy input). It is generally used in the analysis of food production systems (Slesser, 1988; EMC, 1991). Energy analysis of fishing systems operated in Indian waters has been reported by Boopendranath & Hameed, 2009; 2010; Boopendranath et al., 2009; 2010). In this study an attempt has been made to study the fish production and energy requirement in the mini-trawl operations off Cochin, Kerala, India.

Materials and Methods

Energy analysis of mini-trawling and determination of Gross Energy Requirement per tonne of fish landed (GER t $fish^{-1}$), Energy Ratio and Energy Intensity, were carried out following the methodology and conventions recommended by IFIAS (International Federation of Institutes for Advanced Study) (1975) and other authors (Edwardson, 1976; Mittal & Dhawan, 1988; EMC, 1991; Boopendranath, 2000; Boopendranath and Hameed, 2009).

Sources of energy inputs for construction of traditional crafts were collected from traditional craft builders of Chellanam (Ernakulam Dist.), as per the structured Schedule prepared for the purpose. Useful life-time of traditional crafts, was assumed to be 10 years for energy amortisation purposes. Data on design details and rigging of mini-trawls were obtained by field survey, as per a structured Schedule prepared for the purpose. Useful life-time of fishing gears estimated for amortisation purposes was 1 year for mini-trawl.

Data on fish production were collected from different landing points located in Chellanum-Saudi (Ernakulam Dist.) according to a pre-fixed sampling schedule, during 1997-98. Data on fishing operations were collected by discussions with the operators as per a structured Schedule prepared for the purpose and onboard visits. Sample size and sampling frequency were 11.4% (4 units) and every three days, respectively.

Results and Discussion

Design drawing of mini-trawl is given in Fig. 1 and details of rigging and otter boards are given in Fig. 2. Mini-trawl has a two-panel construction. Polyethylene netting of R190tex and R370tex are used for net body and codend, respectively. Mesh size varied from 22 to 20 mm in the wings, net body and codend. Design differed in certain details from the description given by Hameed et al. (1989) and Vijayan et al. (1990). The head rope and foot rope of the mini-trawl were generally of 11.0 and 12.4 m long, respectively. The wing-ends were connected to the otter boards by means of double bridles of 9.5 m polypropylene ropes (10 mm dia). Seven plastic floats of 100 mm dia were attached along the head rope for buoyancy and about 7 kg of iron link chain was attached to the foot rope as sinkers.

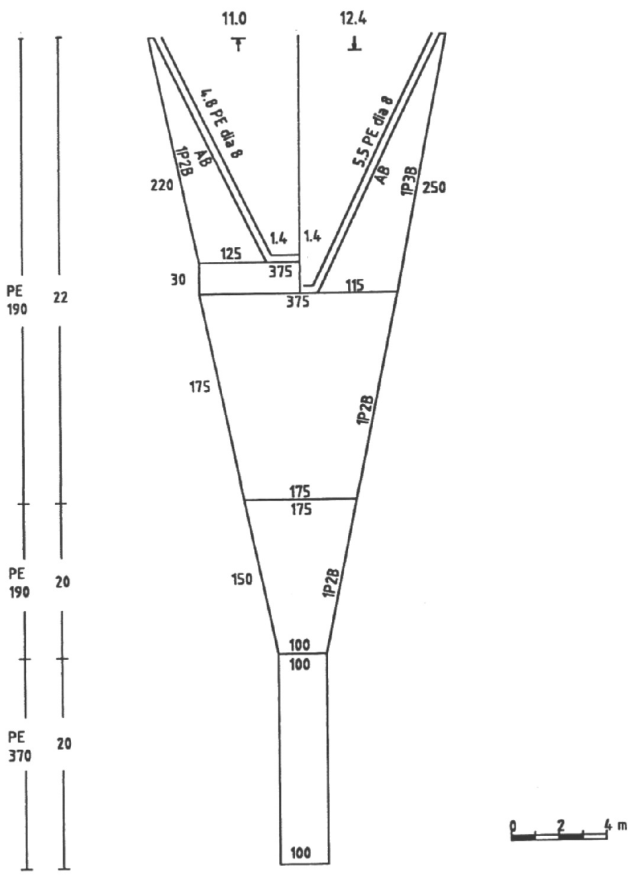

Fig. 1. Design of mini-trawl

Polypropylene ropes (10 mm dia) of 140 m length were used as towing warps. The otter boards used were of flat rectangular type, weighing 16 kg each and constructed of wood and steel (Fig. 2).

Mini-trawls in the study area, were operated from plank-built canoes with transom. The size of the crafts varied from 6.1 to 7.6 m L_{OA}. Plank canoes with transom are being fabricated by seaming together appropriately shaped planks of Jungle jack (*Artocarpus hirsuta*) by means of coir ropes. Fish oil, black oxide and natural resins are used for preservative treatment and water-proofing. The transom is provided with a V-cut in order to facilitate the fixing of outboard motor. A wooden rod of about 2.5 m long and 100 mm dia was fastened to the craft, a little over 2 m, ahead of the stern. Two iron rings of 100 mm dia, one each fitted to the distal ends of the rod, served as towing blocks, during the operation of the gear.

The outboard motors used for propulsion, were of water cooled, two-stroke engine type, generating a maximum output of 12 hp (8.8 kW) at 5,500 rpm. The gear ratio is 2.08 (27:13) and propeller size is 3 x 234 x 203 mm (No. of blades x diameter x pitch). The engine weighs 37 kg. The engine operates on petrol from a small auxiliary tank up to 1500 rpm, and then automatically switches over to kerosene.

Mini-trawl fishermen set out for fishing at 05.00 - 05.30 h, in the morning. Generally, 7 fishermen are attached to a mini-trawling unit and of them 2-5 fishermen go onboard for fishing. Mini-trawls are operated in the coastal waters within the depth range of 5.5 to 27 m. After reaching the ground, the codend is tied and the net, bridles and otter boards are released, followed by warps at a scope ratio of 5 to 15. Normal duration of tow is from 1 to 1.5 h. The fishermen return to the base for marketing the catch, by 13.00 to 14.00 h. This fishing practice is seasonal extending from September to November and again from March to May. Mean number of fishing days per year was 120.

Mini-trawling is generally targeted at coastal prawn resources, particularly *Parapenaeopsis stylifera* and *Metapenaeus dobsoni*. Mean catch per year per mini trawler during the period of study was 10.26 t,

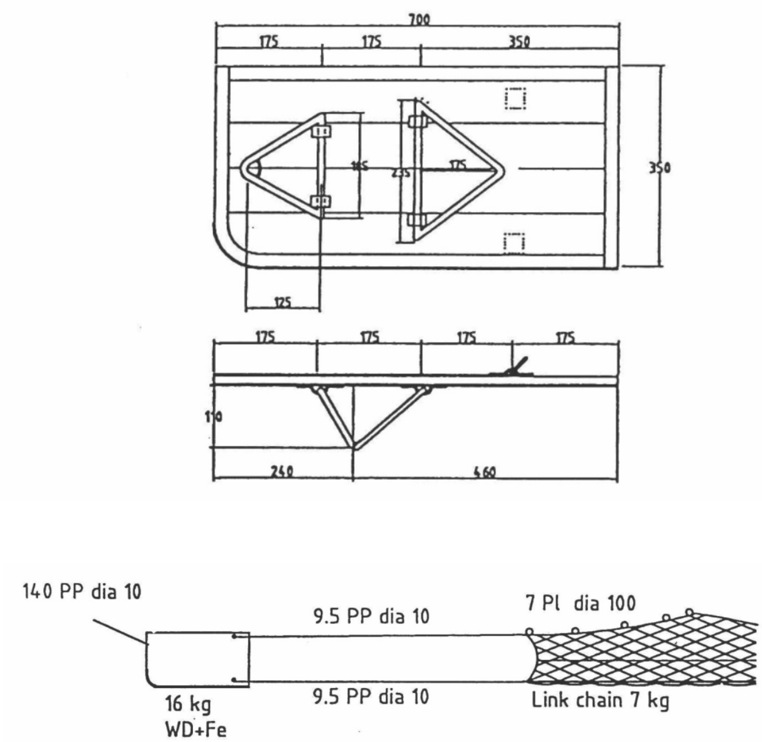

Fig. 2. Rigging details of mini-trawl

Table 1. Results of energy analysis of mini-trawling

	GJ	*Annual GER, GJ*
Operational energy requirement		
Kerosene	178.56	
Petrol	17.36	
Lubricating oil	6.83	
Sub-total	202.76	202.76
Fishing gear		
Mini-trawl with appurtenances	1.327	1.32
Towing warp	0.741	0.74
Otter boards	0.446	0.89
Fishing craft	1.3	0.13
OBM	2.398	1.20
Total		207.04

48.1% of which was constituted by prawns, followed by flat fishes (33.1%), crabs (12.0%) and miscellaneous finfishes (6.8%). The mean catch day^{-1} obtained was maximum during the month of September (160 kg mini-trawler^{-1} day^{-1}). During other productive months *viz.*, October-November and March-May, the catch varied from 54 to 84 kg mini-trawler^{-1} day^{-1} (Fig. 3).

Energy intensity is the amount of energy required to create a unit of output energy (energy input / energy output). It is the reciprocal of energy ratio and is equal to GER expressed in terms of out put energy (Slesser, 1988; EMC, 1991). Results of energy analysis is given in Table 1. Total embodied energy inputs into mini-trawler operation was estimated to be 207.04 GJ and the energy equivalent of fish produced was 38.62 GJ. The GER t fish^{-1} for mini-trawling was estimated to be 20.2 GJ, which is quite high for a coastal fishing operation. Kerosene constituted 86.24% of the GER, followed by petrol (8.39%), lubricating oil (3.30%), fishing gear (1.4%), outboard motor (0.58%) and fishing craft (0.06%). Energy ratio for mini-trawling was 0.19 and energy intensity 5.36.

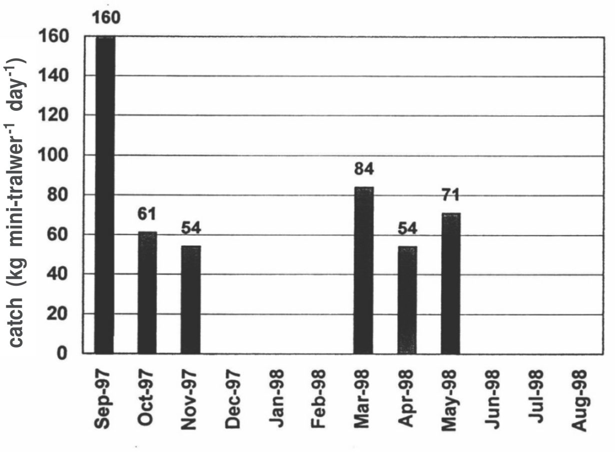

Fig. 3. Mean catch day^{-1} of mini-trawlers

GER per tonne of fish landed by non-motorised gill netting operations has been estimated as 0.61 GJ and that of stake net operations as 5.19 GJ (Boopendranath & Hameed, 2009; 2010). The GER t fish^{-1} determined for mini-trawling (20.2 GJ), was quite high for a coastal fishing operation and extremely high compared to passive fishing methods like non-motorised gillnetting and stake net operations. The predominance of juveniles in the mini-trawl landings and its economic implications has been reported by Ammini et al. (2004), Nandakumar et al. (2005), Najmudeen & Sathiadhas (2008) and others. The mini-trawl operations in the coastal waters need to be strictly regulated in view of the high GER and predominance of juveniles in the landings and the implied negative impacts on environment and resources.

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