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Energy Analysis of Traditional Non-motorised Gill Net Operations, in Vembanad Lake, Kerala, India

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Fish production and energy requirement in the traditional non-motorised gill net operations, in Vembanadu Lake, Kerala, India are discussed in this paper. Gillnetting is targeted at mullets and other estuarine resources and is operated from traditional two-men canoes of 5.5 m L_{OA}, using paddling as means of propulsion. Fishing operations take place from November to July while during the other months it is suspended due to the presence of large quantities of macro-vegetation, drifting downstream. Mean number of days of operation is 225 days. Mean catch per year per gill-netter was estimated to be 8.4 t of which mullets contributed 25.1%, followed by sciaenids 17.1%, carangids 15.5%, cat fishes 13.6%, prawns 13.3% and miscellaneous fishes 15.2%. GER.t fish^{-1} was found to be 0.61 GJ making this one of the most energy efficient system. Nearly 98.92% of the GER is contributed by fishing gear and the balance by the fishing canoe. Energy efficiency ratio was 8.01 and energy intensity value was 0.125.

Key words: Gill netting; Fish production; Gross Energy Requirement; Vembanad lake

Vembanad lake (Kerala, India) situated between 9°28′-10°10′ N lat. and 76°13′-76°31′E long. has an area of 21,500 ha. Exploited fishery resources in the Vemabanad lake have been quantified by Kurup and Samuel (1985a) and Kurup et al. (1993). The annual yield of fishes and crustaceans from the Vembanad lake has been estimated at about 7200 t, consisting penaeid prawns (48.6%), fishes (45.7%), crabs (4.0%) and palaemonids (1.6%). Seine nets, gill nets, drag nets, falling gears, stationary gears including Chinese dip nets and stake nets, and hand lines have been reported to be used for fishing operations (Kurup & Samuel, 1985b; Kurup et al., 1993). Gill nets are an important category of stationary gear operated by the traditional fishermen, in the Vembanad lake (Shetty, 1965; Kurup and Samuel, 1985b; Pauly, 1991). Energy analysis of fishing systems have been reported by Edwardson (1976), Watanabe and Uchida, (1984), Endal (1989), Boopendranath (2000), Tyedmers (2004) and others. Detailed description of design, operation, fish production and energy analysis of gill netting in the non-motorised traditional sector, in the Vembanad lake are given in this paper.

Materials and methods

Energy analysis

Energy analysis of selected fish harvesting systems 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).

Definitions

Gross Energy Requirement (GER) is the sum of all non-renewable energy resources

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consumed in making available a good or service. GER is a measure of intensity of non-renewable resource use. It reflects the amount of depletion of earth's inherited store of non-renewable energy in order to create and make available a good or service (Slesser, 1988). Renewable energies and human energy are not included in the GER. In this study, GER in the fish harvesting up to the point of landing is estimated.

Energy ratio or Energy efficiency ratio is the ratio between metabolizable (i.e. food) 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 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 output energy (Slesser, 1988; EMC, 1991).

Data sources for energy analysis

Fishing craft, gear and operational inputs

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 fishing gears were obtained by a survey of fishing gears operated from fish harvesting systems selected for the study, as per a structured Schedule prepared for the purpose. Useful life-time of fishing gears estimated for amortisation purposes was 1 year for gill nets operated from non-motorised crafts.

Fish production and operational details

Data on fish production were collected from different landing points located in Cochin, 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 short onboard visits. Sample size and sampling frequency were 6.3% (5 units) and every three days, respectively.

Results and Discussion

Description of the fishing craft and gear

Traditional non-motorised canoes of sizes ranging from 4.6 m to 7.6 m but typically around 5.5 m, manned generally by two fishermen, are used for the gill-netting operations. The dugout canoe is made, as the name implies, by scooping out wood from a single log of mango (*Mangifera indica*) or jungle jack (*Artocarpus hirsuta*). The keel portion is left thicker than the sides which are hollowed out so as to form internal stiffening ribs. The plank canoe is made by seaming together several suitably shaped planks of jungle jack (*Artocarpus hirsuta*) with coir ropes. The finished canoe is treated with a compound consisting of sardine oil and black oxide. Design drawing and details of the gill nets studied are given in Fig. 1 and Table 1, respectively.

Total length of the gill net operated is 180 m, each of five different mesh sizes. The hung depth varies from 2.6 to 5.6 m. The gill nets studied were primarily targeted at mullets, which formed the bulk of the landings by this gear. The predominant mesh size was 36 mm and other mesh sizes in use were 30 mm, 34 mm, 40 mm and 65 mm. In the gill nets studied twine size used was 23 tex (0.16 mm dia) and twine diameter-mesh size ratio ranged from 0.0053 to 0.0025.

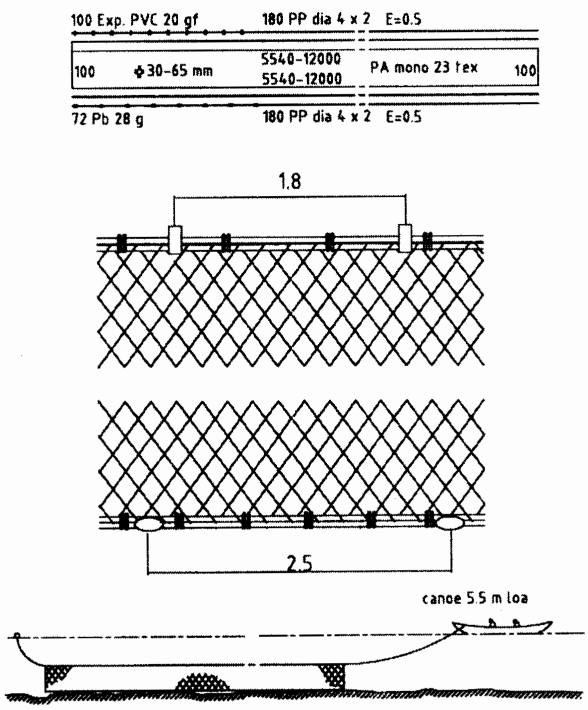

Fig. 1. Design of gill nets operated from traditional non-motorised crafts

Most common netting material for gill nets studied was polyamide monofilament.

Fishing operations

The gill nets were operated from traditional canoes of about 5.5 m size, manned by one or two fishermen, using paddling as the means of propulsion. The fishermen set out for fishing early in the morning at day-break and return by noon, for selling the catch. Gill nets are set across the current. The gear is set over the side of the craft. The buoys and sinkers are thrown overboard manually to either side of the net to prevent tangling. After completion of the setting, the end of the net is kept tethered to the boat. Soaking time is generally 1-2 hours.

Fishing operations take place from November to July. During other months fishing operations are suspended, due to the presence of large quantities of macro-vegetation, drifting downstream. Mean number of days of operation in a year, is 225 days.

Table 1. Salient features of drift gill net

Target species	Mesh size, mm	Twine size, tex	Material	Hung depth, m
Mullets and small clupieds	30	23	PA mono.	3.0
Prawns (*P. Indicus*)	34	23	PA mono.	3.4
Grey mullets	36	23	PA mono.	3.6
Croakers, catfish, perches	40-65	23	PA mono.	4.0-6.5

Catch and catch composition

Month-wise average production per boat is given in Fig. 2 and catch composition is given in Fig. 3. Mean catch per year per gillnetter was estimated to be 8.4 t. The most productive months during the period of observations were May to July giving a mean catch per day of 5.5 to 6.2 kg, foilowed by March and April (3.5 - 4.5 kg.day^{-1}), and November to February (2.5 - 3.2 kg.day^{-1}). The major species groups landed were mullets (*Liza parsia, Mugil cephalus* and *Valamugil spiegleri*) constituting 25.1%, followed by sciaenids (17.1%), carangids (15.5%),

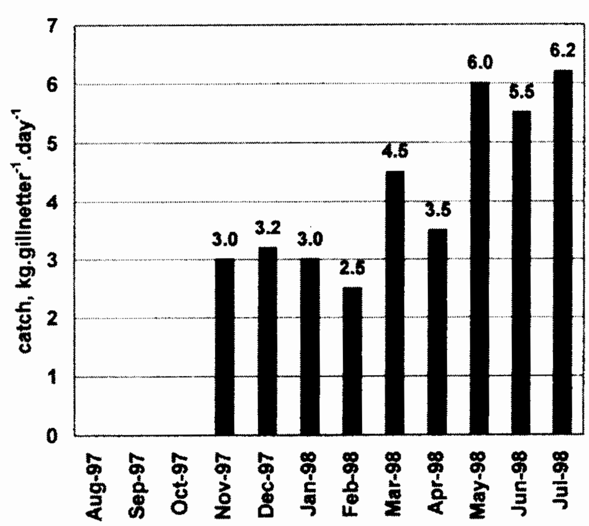

Fig. 2. Mean catch.day^{-1} of traditional non-motorised gillnetters.

cat fishes (13.6%), prawns (13.4%) and miscellaneous fishes (15.2%).

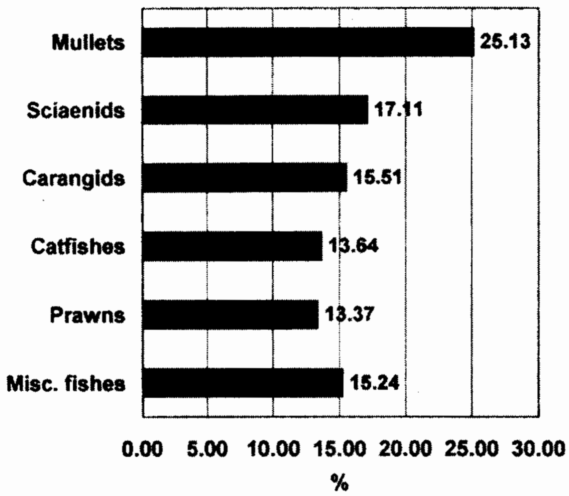

Fig. 3. Catch composition of traditional non-motorised gillnetters

Energy analysis

Results of energy analysis is given in Table 2 and Figs. 4 and 5. The fish harvesting system under study did not incur any operational energy expenditure in terms of non-renewable resources.

The sequestered energy were estimated as 0.055 and 5.091 GJ, respectively for craft and gear (Fig. 4). Thus, nearly 99% of the total GER was contributed by the fishing

Table 2. Results of energy analysis of non-motorised gillnetting

	GJ	Annual GER, GJ
Operational energy requirement	nil	
Fishing gear		
Netting	0.61	
Ropes	3.752	
Lead sinkers	0.324	
PVC floats	0.405	
Subtotal	5.091	**5.091**
Vessel	0.554	**0.055**
Total		**5.146**

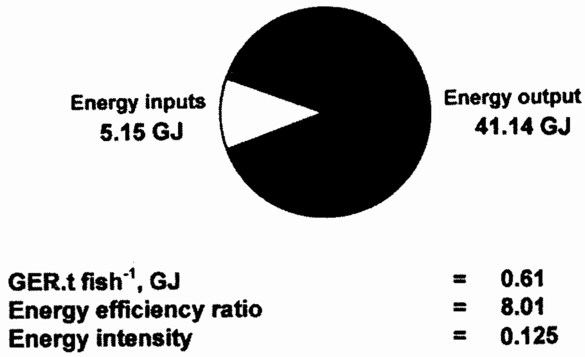

Fig. 4. Results of energy analysis of traditional non-motorised gillnetters

gear and the balance by the fishing craft (Fig. 5). GER per tonne of fish landed was estimated to be 0.61. Efficiency ratio worked out to be 8.01. Energy intensity value obtained was 0.13. This very low energy requirement for traditional non-motorised gillnetting is in sharp contrast to the motorised and mechanised fishing operations (Edwardson, 1976; Watanabe and Uchida, 1984; Endal, 1989; Boopendranath, 2000; Tyedmers, 2004).

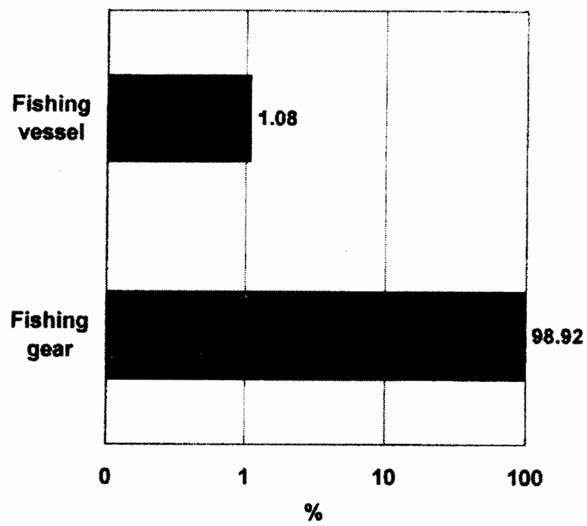

Fig. 5. Percentage contribution of energy inputs to GER of traditional non-motorised gillnetters

Traditional non-motorised fishing, as practiced in Vembanad lake has very low GER, per unit weight of fish landed. This fish harvesting system did not incur any operational energy expenditure in terms of non-renewable resources, and the sequestered energy for craft and gear were the only sources of energy consumption.

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