Hooks and Line Fishery Resources of India

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The paper provides information on the present status of hooks and line fisheries in the coastal waters of India based on information culled out from published accounts, unpublished project reports of CMFRI and studies conducted at selected centres. The geographic and bathymetric regions along Indian waters where the gear is in wide operation and the exploitation of different resources by the gear in various seasons are also dealt with. Hand line fishing conducted along coastal uneven grounds of coral, rocky outcrops during selected seasons by migrating fishermen and the resources vulnerable to this gear are also presented. The significance of pole and line operation for tunas in Lakshadweep waters is described. All India, state-wise and region-wise catch, effort and catch rates of groups/species exploited by hooks and line during the period 1985-89, specific bait used in each region, ecology of the fishing terrain are incorporated, along with suggestions and recommendations to conserve resources, manage and develop this fishing technique along Indian waters.

Of the several types of traditional fishing methods,the hooks and line formed one of the most dominant and economically viable fishing technique to exploit large pelagic, column and demersal predator fishes. There are about 57,000 hooks and line units in India, which is the second dominant gear for marine fishing, next to drift/gill net, with the maximum number in Tamil Nadu (39%) followed by Orissa (27%) and Andhra Pradesh (19%) (Anon, 1981).

Central Institute of Fisheries Technology made some studies (Kartha *et.al.*,1973; Rao *et al.*, 1989) on the effectiveness of hooks to catch predator fishes based on hook size and various prey organisms.

The studies on the line fisheries such as longline, hand line and pole and line of coastal Indian waters by mechanised and non mechanised units were attempted by several workers (Luther *et al.*, 1982; Gopakumar *et al.*, 1986; Lal Mohan & Nandakumar, 1988; Menon *et al.*, 1989; Sukumaran *et al.*, 1989, Grace Mathew & Venugopalan, 1990; Jayasankar, 1990). Studies conducted at selected centres, revealed that the gear is very effective to exploit large predator fishes such as catfishes, elasmobranchs, tunnies, seerfishes, perches etc. from uneven non-trawlable fishing grounds of coastal waters with coral or rocky outcrops. The paper presents all India, state- wise, centre-wise and season-wise hooks and line catch, effort, catch rates, species composition and fishing areas.

Materials and Methods

The data pertaining to this study were collected from NMLRDC of CMFRI for catch and effort. Investigations conducted by CMFRI from selected important fishing centres provided monthly catch, rate of production, species composition; geographi cal, seasonal and bathymetric yield and abundance of the major predatorfishes caught in the gear.

Results and Discussion

Three categories of hooks and line such as ong line, hand line and pole and line are in vogue and all of them are operated from non-mechanised catamaran, canoe or mechanised (OBM) catamaran, canoe or mechanised pablo boats (30'). Both long-line and hand line are widely operated all along the coastal waters and sometimes upto 150 m depth, depending on the fair-

Table 1. *Statewise percentage contribution of major groups of fishes in long line catch (average for 1985-89) ranks in parenthesis*

Groups of fishes	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karnataka	Goa	Maha-rashtra	Gujarat
Sharks	0.7	9.1(3)	12.6(3)	84.9(1)	1.9	3.7	77.4(1)	14.3(4)	11.8(3)	32.1(2)
Skates and Rays	20.7(2)	26.9(2)	4.8	1.6		1.0	1.6	-	1.1	1.0
Catfishes	76.1(1)	45.8(1)	27.2(2)	0.4	1.9	14.4(3)	8.3(2)	22.8(3)	62.4(1)	33.6(1)
Rock cods	-	-	-	1.9	-	2.5	1.3	-	-	0.5
Snappers				0.9	11.3(5)	2.1	-	-	-	-
Threadfin breams	-	-	-	-	7.5	4.5	-	-	-	-
Other perches	0.1			2.4(3)	17.9(3)	2.8	1.3	28.6(1)	0.6	-
Seer fishes	-	4.9 (5)	28.0(1)	1.0	13.2(4)	5.7(5)	5.1(3)	-	17.2(2)	-
Mackerel	-	2.0	-	0.3	-	4.8	-	-	-	-
Tunas & Billfishes	-	-	10.1(4)	3.3(2)	3.8	19.2(2)	-	-	-	-
Carangids	-	3.6	8.0	2.2(4)	22.6(1)	22.3(1)	4.6	8.6(5)	0.6	3.0
Clupeids	-	-	0.2	-	-	1.8	-	-	-	-
Other fishes	2.4(3)	7.6(4)	9.1(5)	1.1	20.7(3)	9.8(4)	3.4(4)	25.7(2)	0.3(4)	29.8(3)
Total catch (t)	753	607	3939	2624	53	16313	314	35	3016	405
Percentage in total hooks and Line catch	2.7	2.2	14.0	9.3	0.2	58.1	1.1	0.1	10.7	1.4

ness of the season, availability of predator fishes etc. whereas the pole and line fishery is practised only in the Island waters of Lakshadweep exclusively for tunas. A wide variety of small fishes are caught in hand lines (small hooks) operated along shallow waters; whereas the same gear with larger hooks yielded few species of large predator fishes when fished in deeper grounds of rocky/coral bottom. The long liners with larger hook caught large pelagic and demersal fishes belonging to a narrow spectrum. There are regional variations with regard to the number of hooks used in each line, length of snood, size of hooks, hook combinations and bait organisms.

Long Line Fishing

All India annual average long line landings for the years 1985- 1989 was estimated as 29,526 (1.7% in total fish production) with the maximum contribution by Kerala (58.1%), followed by Andhra Pradesh (14%), Maharashtra (10.7%) and Tamil Nadu (9.3%). The species-wise composition is given in Fig.1. Cat fishes formed the major constituent. Table 1 represents the statewise landings of the different species. Cat fish

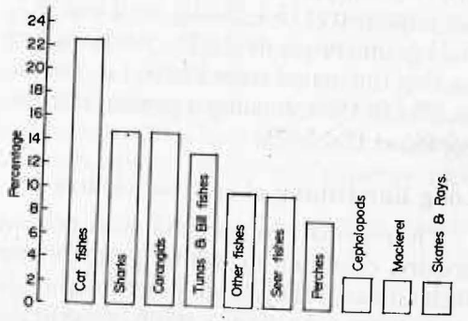

Fig. 1. Species composition (%) of long line landings.

Table 2. *Statewise long line catch (t), CPUE (kg) and % in total catch for 1985-89*

States	1985 Catch	1985 CPUE	1985 % in total catch	1986 Catch	1986 CPUE	1986 % in total catch	1987 Catch	1987 CPUE	1987 % in total catch	1988 Catch	1988 CUPE	1988 % in total catch	1989 Catch	1989 CPUE	1989 % in total catch
West Bengal	326	50.5	1.4	262	45.9	1.6	250	42.0	1.1	365	35.0	3.0	2545	217.6	6.9
Orissa	535	40.1	1.1	-	-	-	2566	73.7	4.4	-	-	-	447	131.9	0.9
Andhra Pradesh	5571	27.7	4.6	4359	26.5	2.9	3693	22.9	2.7	4902	18.7	4.0	4460	24.4	3.6
Tamil Nadu	558	62.6	0.3	2743	379.4	1.1	3886	357.5	1.3	3532	18.6	1.2	4218	446.9	1.5
Pondicherry	1	17.9	-	-	-	-	24	44.4	0.2	37	99.7	0.3	206	225.1	1.7
Kerala	13934	15.4	4.3	14534	33.3	3.8	1434	28.3	3.8	22884	33.7	4.9	20721	32.0	3.2
Karnataka	2	31.7	0.2	-	-	-	131	24.9	0.1	412	271.9	0.2	821	214.9	0.3
Goa	75	71.2	0.2	41	34.1	0.1	47	111.1	0.1	8	117.7	0.1	-	-	-
Maharashtra	711	226.7	0.2	3448	362.3	1.1	2270	246.9	0.8	6492	200.7	2.1	2158	114.9	0.6
Gujarat	387	159.1	0.1	107	93.7	0.1	301	192.9	0.1	743	236.8	0.4	485	116.8	0.2
All India Total	22100		1.4	25494		1.5	24602		1.5	39375		1.8	36061		2.1

was dominant in West Bengal, Maharashtra and Orissa. Seer fish in Andhra Pradesh, sharks in Tamilnadu and Karnataka and carangids in Kerala. In other states, dominance of any particular species was not evident. The state- wise long line catch during 1985-89 period indicated high hooking rates in Tamilnadu (67.6-446.9 kg/ unit), Maharashtra (114.8-362.3 kg/unit) and Gujarat (116.8-236.8 kg/unit) almost throughout the period and in Karnataka (214.9-271.9 kg/unit) during 1988-1989. Though the long line production of Kerala and Andhra Pradesh was high, the catch rate remained at 15.4-33.7 kg/unit and 18.7-27.7 kg/unit respectively. The total long line landing fluctuated from 22,100 t in 1985 to 39,375 t in 1988 showing a general increasing trend (Table 2).

Long line fishing at selected centres

The regional climatic conditions, bottom texture, condition of fishing grounds and their faunastic abundance affect the strategy of the fishing. As the non-mechanised liners cannot cope with inclement weather and unusual drift/current during monsoon months, either the fishing is carried out during pre-monsoon and post-monsoon months or the liners migrate to suitable areas, where the sea is calm.

Long line fishing in Jamnagar district of Gujarat produced catfishes as the major component group. Fishing is done in shallow rocky areas within 8 km from shore (20-30 m depth) both during day and night. In each line 1000 hooks of No.6-8 are attached at two m intervals with squids/Octopus as bait. The major species of catfishes were *Tachysurus dussumieri, T.sona, T.caelatus, T.thalassinus* and *Osteogeneiosus militaris* in the order of abundance. In this region long liners produced high catch rates during September-April months (Sarvayia & Malli, 1991).

The long line fishing at Bombay yielded 308.5 t in 1989, the major fish groups caught were catfishes (70%) and elasmobranchs (21%). The seasonal catfish catch by the gear ranged from 0.8 t (July) to 54.9 t (November) with corresponding catch rates of 80 and 197 kg/unit effort. The last quarter of the year produced high catches of catfishes and the frequently caught species were *T.dussumieri* (95.5%). *T.sona* (2.7%) and *T.caelatus* (1.80%). The monthly elasmobranchs production ranged from 0.9 t (June) to 15.9 t (October). Sharks accounted for 74% and rays 26% in the total elasmobranch catch.

The long liners in Karwar operate in coastal water upto 50 m depth during October-May period with an average annual yield of 15.3 t (1975-80). The catch composed mainly of catfishes (55.1%) and elasmobranchs (44.9%). The production rate was 30.9 kg/unit effort for catfishes and 25.2 kg/unit effort for elasmobranchs.

The migratory fishermen from Kerala, recently (1987) successfully introduced the long line fishing along Karnataka (Male-Kolam) for deep sea sharks. They operate from small mechanised boats (9.7 m with 47 HP engine) during September to May in deeper waters of 100 m and above. The bait used was pieces of tuna and dolphin. During 1987- 88 the estimated catch by the gear was 2000 t of shark with peak landing during November-December. The important species of sharks landed were *Carcharhinus sorrah, C.melanopterus* and *Sphyrna lewini*. The return per trip was estimated to be as high as Rs.30,000 per unit. Attracted by this high returns, recently some of the local trawlers and gill netters have switched over to longlining (Sukumaran *et al.*, 1989)

Set long line fishing for sharks along Kerala coast was practised from country craft and catamaran till 1978. This gear is now operated from mechanised crafts (Mohan Rajan, 1982).

Long liners operate regularly from two fishing centres, Vellayil and Elathur at Calicut. At Vellayil, the catch by the gear varied from 54.1 t in 1989 to 493 t 1980. Marine catfishes formed on an average (1979-1985), 91.7% in the total fish catch of the gear. *Tachysurus tenuispinis* accounted for 48.7% of the total catfish catch which is followed by *T.dussumieri* (28.5%), *T.thalassinus* (20.5%) and *T.serratus* (2.3%). Their catch rate fluctuated from 132.6 kg to 210.8 kg during 1979-1985 with two peak occurrences in September-December and January- March. Sharks belonging to the species *Scoliodon laticaudus* (70%), *Carcharhinus melanopterus* (20%) also occur in substantial quantities in this gear. Fishing is carried out in depths of 10-70 m. Different sizes of hooks (No.9-23) are used in the same line and each fishing unit carried upto 2000 hooks and fishes such as sardines, small sciaenids are used as bait. From 1980 motorised country crafts were used for line fishing.

At Elathur, drift long lines are operated from country crafts/OBM units in deeper waters (upto 120 m) for the exploitation of sharks. The snoods used are Ponnani type as described by Rao *et al.*, (1989). The fishing takes place round the year, except for the monsoon months, with peak catches during January- April period. Hook No. 1-4 are used with live eels cut into blood oozing pieces as bait. Major species caught are *Carcharhinus limbatus* (47%) and *Sphyrna lewini* (43%) and the less abundant species landed were *C.dussumieri, C.sorrah, Galeocerdo cuvieri* and *Rhizoprionodon acutus*. During 1989 the long liners landed 367 t of sharks and the catch rate ranged from 95 kg in November to 716 kg in February. The total during 1965-75 ranged from 433 to 1638 t with a mean of 1028 t per year (Luther *et al.*, 1982). Production of non-mechanised and mechanised (OBM) hooks and line units operated off Vizhinjam in depths of 40-50 m and 60-80 m was 229 kg and 62.5 kg respectively unit effort in 1983.

The line fishery at Tuticorin exists throughout the year and mostly carried out by traditional non-mechanised and mechanised crafts. Each fishing unit consists of 1000-1300 'Mustad' No.7 hooks. Lesser sardine and chank meat are used as bait. The liners operate off Tirunelveli coast between 8°-9° lat.at depths of 35- 60 m in the coral reef area. The annual production during

1980-88 ranged from 133 t (1981) to 694t (1985) with better landings in January, February, August and September. Perches accounted for 65.6% of the total line catch and the common species were *Lethrinus nebulosus* (27.3% in perch catch) *Lethrinus* spp.(13%) *L.miniata* (5.9%). *Epinephelus* spp. (14.5%), *Serratus* spp. (22%) and *Diagramma* spp.(1.3%). Perch landing has two peak periods of occurrences in July-November and April-May. The next dominant species are sharks, carangids, catfishes, rays and seerfishes in the decreasing order of yield. (Sam Bennet & Arumugam, 1989)

The long line fishermen from Tuticorin migrate towards Pamban and Mandapam region during December-March period to operate hooks and line from in board engine fitted country crafts in the reef areas of Dhanushkodi at depths of 18-25 m. Mustad No. 7 hook is used in the longline. About 1000-3000 hooks are attached in each line and Sardinella spp. are used as bait. *Lethrinus*. spp. accounted for 34% of the total fish yield, the next dominant predator was *Lutjanus* spp. (23%) followed by sharks (9.6%), rays (8.4%), *Epinephelus* spp. (6.9%) and *Prestipomodies* spp.(4.7%) (Jayashankar, 1990).

The hooks and line fishery at Lawson's Bay, Visakhapatnam yielded 111.4 t of fishes during 1989-90 with a catch rate of 4.2 kg/unit. The liners operate throughout the year with peak catches during March-May and September-November months. Catch was composed of predatory fishes like *Scomberomorus commersoni* (37.6%), *S. guttatus* (18.9%), *Istiophorus platypterus* (8.8%), *Euthynnus affinis* (7%), *T.thalassinus* (6.7%), *Carcharhinus sorrah* (6.3%) etc.

The Experimental Long Line Fishery

There was no organised commercial fishery for the resources namely, tuna, bill fishes and shark except the pole and line fishery of Lakshadweep. During the last few years the FSI ventured to explore the extent and magnitude of tuna resources in Indian seas. The results indicatedd that *Thunnus albacares* (Yellowfin tuna), *T. obesus* (Bigeye tuna), *Katsuwonus pelamis* (Skipjack tuna), and *T.alalunga*. (Albacore) form 46.1% of the total long line catch, which is followed by pelagic sharks (41.2%), bill fishes and sail fishes (9.3%) and the remaining by dolphin fish, seer fish etc.The survey revealed that the hooking rate (number of fish/100 hooks) was 3.35 in Arabian sea followed by east coast (1.99), equitorial waters (1.91) and Andaman sea (1.51). That the share of tuna in long line catch from Arabian Sea is as high as 49.6%, is a positive indicator for extensive long line exploitation in the high seas. Around Agatti, Kadamat at depths of 30-110 m an average hooking rate of 8.4 with 95% of the catch composed of sharks was obtained. Attracted by the high economic return from the long line operations now there are 15 units regularly operating long line from Lakshadweep (George Varghese, 1991).

Hand Line Fishing

Hand line was operated from all along the coastal waters with better catches from Andhra Pradesh, Kerala, Tamilnadu and Orissa. Rock cods formed 45.5% of the total catch followed by snappers (27.7%), sharks (14.3%), tunnies (5.5%), carangids (2.6%) and other perches. In Kerala and Tamilnadu, rock cods, snappers and sharks accounted for the bulk of the hand line landings. Snappers and other perches were the dominant landing from Andhra Pradesh.

The migrating fishermen from Trivandrum and Kanyakumari Districts conducted seasonal hand line fishery at different centres of the southern states, mostly along rocky/coral grounds of the south-west and south-east coast of India in depth ranges of 30-150 m from non-mechanised and mechanised (OBM) canoes, cataramans or small mechanised pablo boats.

Hand line fishing at selected centres

Fishing is done along Malabar coast (Calicut) during October- January season in the rockey beds at 20-30 m depth. The major catch is *S. commersoni* (45.3%), *Sphyraena* spp. (46.8%), *Rachycentron canadus* (5%) and the remaining by *Sepia pharaonis* (Lal Mohan & Nandakumaran, 1988).

The hand line fishery of Cochin is mainly aimed for Kalava, available in the outershelf off Ponnani and Alleppey in the depth belts of 75-125 m. About 90 units operate from Cochin base for Kalava and bring the catch on alternate days. About 4 to 6 synthetic monofilament (2 mm dia) lines each with 5 to 15 hooks (No.7 and 8) are used from each unit with pieces of fish flesh as bait. The catch ranged from 150-700 kg per unit in the peak season and the annual landing fluctuated from 49 t (1962) to 735.1 t (1987) with a mean of 237 t. *Prestipomoides typus* (51.4%), *Epinephelus diacanthus* (19%) accounted for about 90.3% of the total hand line catch during 1982-1988 period, which is followed by elasmobranchs (4.4%) and tunas (2.9%). The hooking rate was the highest in January due to the clarity of the water in the fishing grounds during this season (Grace Mathew & Venugopalan, 1990).

About 50 hand line units operate from Pulluvila fishing village during January-April period. This gear operated from deeper waters (50-150 m) along rocky grounds off Quilon for Kalava fishing with silver bellies, *Decapterus russelli* etc as baits. During 1980-81 period the catch rate varied from 32-41 kg/unit and Lutjanids formed more than 72% of the total catch of the gear (Madan Mohan, 1983).

Hand line operation (Achil) is very prominent along Vizhinjam waters and the catch includes *Dussumieria* spp. (25%), lesser sardines (20%), carangids (13%), *Decapterus* spp. (11%) etc. Active operation of the gear is during May, June and August, when about 87% of the annual effort is expended, landing 93% of the annual catch by this gear with a catch rate of 5.4 kg to 14.3 kg/unit (Luther *.et al.*, 1982). Recently Joel *et al.*(1989) described light fishing for carangids by employing 'achil' during December-January period along the waters of Trivandrum District. The OBM canoes (about 900 units) carried out fishing during night with kerosine lamps at depths of 85-110 m and yielded 100-350 kg/unit, mostly of *Selar crumenophthalmus*. Estimated catch is about 2000 t in a fortnight period.

The hand line is operated from Tuticorin round the year and the annual landings fluctuated from 240.6 t (1982) to 378 t (1983) with an average of 309 t during 1980-85 period. The annual catch rate ranged from 58 kg to 85.5 kg/unit effort with a mean of 78.4 kg/unit and the best period of landing was from January-March. Threadfin breams accounted for about 36% of the total catch and the next important predator species were lethrinids (20%), *Belone* spp. (19%) serranids (10%) and carangids (6%) (Sam Bennet & Arumugam, 1989).

Pole and line fishing

The pole and line fishery is concentrated around Minicoy, Agatti, Bangaram, Perumal Par reef, Suheli par and Bitra island. It is the mainstay for tuna fishery of Lakshadweep islands, which is (1) relatively less capital oriented (2) able to harvest small schools and (3) providing self employment for nearly 5000people. The total tuna catch in Lakshadweep by this gear fluctuated from 1116 t in 1977 to 4355 t in 1984 with a steady uncrease from 1981 to 1984. Skipjack tuna, *Katsuwonus pelamis*

(86%) and yellowfin tuna, *Thunnus albacares* (11%) constituted the major tuna resource and is caught with live baits. The season of high production is post-monsoon and pre-monsoon months. The average annual production rate has been estimated as 17.8 t/unit with highest catch rates from Agatti (46.7 t/unit) forming 53.1% of the total tuna production (James & Pillai, 1991).

The hooks and line is the second dominant gear for marine fishery in the artisanal sector. This technique underwent only minor changes/modifications with regard to size of hooks, number of hooks in a line, bait organism and resource availability. Hooking rates and selective action of baits alone were taken into account for refinement of line fishing technique. Experimental fishing to study the selective action of baits and hooks on bottom-drift-longlines operated off Veraval showed that Mustad round bent No.5 hook with sciaenids as bait were most effective for capture of elasmobranchs (Kartha *et al.*, 1973). Latest studies conducted by Huse & Ferno (1990) on the behaviour of cod and haddock to baited hook proved their hypothesis, that "a long line hook with its point towards the line of pull will catch more cod and haddock than a hook with its point parallel to the line of pull" and concluded that the wide-gap and 'rush' hooks with their point towards the line of pull yielded significantly higher catch rates than the conventional Norwegian Mustad hooks with the point parallel to the line of pull. The behaviour of the predator fishes to the baited hooks has an important bearing on the ultimate hooking rate.

Catfishes are the most important component in hooks and line (23%). The exploitation of this resources by trawlers and purse seiners from shallow grounds (less than 50 m) face severe threat to recruitment. Studies conducted by Menon *et al.*(1989), revealed that hooks and line fishing is a manageable, rational harvesting method for catfishes, as this gear has an inbuilt natural selection for non-brooders and non-spawners, both for economic reasons and conservation point of view.

As the fishery resource abundance in the coastal waters are stagnating, it is important to extend the area of operation to deeper waters of the outer shelf. The energy requirement for passive gear fishing is limited to populsion of the craft to the fishing grounds and even this can be minimised by resorting to use of sail.

Fishing conducted along the rocky beds of Wadge bank, coral reef/rocky grounds of Gulf Mannar and rocky stretches along Ponnani-Quilon indicated that line fishing is high yielding and economical for quality fishes. The Wadge bank and Gulf of Mannar areas with an estimated biomass of about 63,000 t of fishes (Sivaprakasam, 1987) are ideal for exploitation of predator fishes (perches, 39%; shark and rays, 17%, barracudas, 13%; carangids 7% etc. in the total fish biomass) by hooks and lines.

As regards the economic efficiency of the hooks and line operation based on a case study by Sathyadas & Panikkar (1988) along Trivandrum coast, the fixed cost was the least (3 ps for each rupee earned) for catamarnas with hooks and line. The total cost constitutes 77% of the gross income and the pay back period is about five months. Catamaran with hooks and line are highly suitable for the small investors who are capable to go for fishing in their own units. Motorisations of country craft in Kerala (Balan *et al.*, 1989) revealed that the rate of return was highest with hooks and line from motorised canoe (65%) and catamaran (54%) compared with boat seines and gill nets. The fish production per litre of oil was moderate in hooks and line (21.7 kg/1 in canoe and 16.9 kg/1 in cataraman) compared to motorised gill nets (14.7 kg/1).

As the motorised canoe and catamaran with hooks and lines can reach deeper areas for fishing operations, the yield was composed mostly of quality predator fishes,fetching high value per kg of fish. The price realised per kg of fish was the highest (Rs.6.74) for motorised catamaran with hook and line followed by motorised canoe (Rs.3.81) as against R.3.98 and Rs.1.28 for gill net and boat seine (Balan *et al*, 1989). The returns to labour was the highest (R.77/day/person) for motorised catamaran with hooks and line and Rs.48/day/person for canoe, whereas it was only Rs.34 and Rs.24 for gill net and boat seine respectively. The study further revealed that the passive gear operation provides employment at the minimum investment cost. John Kurian & Rolf Willmann, (1982) reported that in Kerala the investment per crew was around Rs.546-1271 for hooks and line fishing, Rs.886 - 952 for boat seines, Rs.1146-3144 for gill nets and Rs.26650 for trawl net, indicating that the low energy fishing is attractive.

Appropriate technologies or any new innovations in the artisanal passive gear sector must be based on concepts, relevant to and acceptable to the communities for which they are intended. The declining fuel energy resources and its high cost point to the probability that the artisanal sector using passive gear may form the mainstream of exploitation, rather than the periphery, in future.

Recommendations

1) Diversification of low energy fishing techniques and redeployment of available mechanised units, which yielded poor returns, for hooks and line fishing.

2) Appropriate commonly available cheap baits may be introduced after a careful study on the food spectrum and perference of the component predator species regularly caught in the gear.

3) Combination of hooks and length of branch line may be determined based on a thorough study on the ecology and bathymetry of the fishing grounds, behaviour and feeding habits of the target or amenable species and the seasonal surface/bottom drift/current patterns in the fishing grounds.

4) Based on the available knowledge on the seasonal, vertical and horizontal migrations towards shore of some of the predator fishes (Catfishes, barracudas, etc.) the line fishing may be redeployed to shallow suitable grounds there by reducing fuel consumption for propulsion and the cost of operation.

5) The length of the snood may be suitably adjusted, based onthe seasonal vertical ascent or descent of the demersal and column predators such as catfishes, perches, barracudas etc for increasing the rate of production.

6) Experimental behaviour studies of selected predator fishes such as catfishes, perches, seerfishes and sharks may be conducted in confined environments to study their behaviour and mode of bite/attack towards different baits and hook types.

7) To reduce fuel requirements, power boats/OBM boats may be equipped with sails, whenever wind is favourable, as an alternate source of energy for fishing or propulsion or both.

8) Atrificial reefs or FADs may be developed for aggregation and concentration of fish resources from where passive gears can be operated with minimum energy consumption for propulsion.

The authors are thankful to Dr. P.S.B.R. James, Director, Central Marine Fisheries Research Institute, Cochin for his kind encouragements.

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