Chapter 3

Sustainable fishing practices

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India is situated north of the equator between 8°4' and 37°6' north latitude and 68°7' and 97°25' east longitude, is the largest peninsular country in the world bordered by Arabian Sea in the west, Indian Ocean in the south and the Bay of Bengal in the east. India has a coastline of 8118 km and 0.5 million sq. km continental shelf endowed with 2.02 million sq. km of Exclusive Economic Zone (EEZ). There are 3,432 marine fishing villages and 1,535 marine fish landing centres spread across nine maritime states of the country, viz., Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal and the union territories of Puducherry and Daman & Diu. The number of fishermen in India has been estimated at around 4 million, of which more than 90% are from traditional fishermen families. The Indian fishing sector falls under three broad categories viz. the mechanised sector, using mechanised propulsion and fishing operations, motorised sector using engines for reaching fishing ground and the non - motorised sector which do not use engine power According to CMFRI (2012) there are about 1,99,141 marine fishing fleet are operated along the Indian coast. In this 72,749 were mechanised fishing vessels, 73,410 were motorised fishing vessels and remaining 52,982 were Non-motorised fishing vessels.

The ICAR - CIFT has been spear heading research in fishing and fish processing in the country for the past decades. The Fishing Technology Division of ICAR - CIFT has been involved in the development of eco - friendly and sustainable technologies for fish harvesting. The division caters to the needs of the non - motorised, motorised and mechanised sector of the fishing industry.

Rubberwood canoes

The non- motorised sector is operated by artisanal fishermen who are economically backward and investment in this sector is heavy due to increasing cost of fishing implements low cost technologies developed by ICAR - CIFT which can reduce investment cost can be taken up by entrepreneurs. Some of these technologies are described below.

A simple technology for development of traditional fishing canoe from rubber wood, which comes as a waste from rubber plantations. Though rubber wood is comparable to many structural timbers in terms of mechanical properties and working qualities, it is highly perishable under marine conditions. The study proved rubber wood as suitable for construction of canoe after upgrading by chemical preservative treatment. This technology relates to increasing the durability of the low cost and highly perishable timber like rubber wood for marine purposes. Through proper preservative treatment it is utilized for construction of small fishing canoes for inland and marine fishing. This will reduce the investment cost of the artisanal fishing craft. This is achieved through treatment of the wood with preservatives like copper chrome-arsenic (CCA) which is a water-borne preservative and creosote which is an oil-borne preservative. The preservative treatment increases the durability of wood, prevents attack of the marine borers and does not affect the strength of the treated wood. The chemical treatment process was standardized to suit the requirement of the rubber wood for using it as a boat building material. This was achieved through an initial dip treatment of freshly felled planks in 2% CCA followed by stabilization of moisture content.

The use of rubber wood, which comes as a byproduct from the rubber plantations, for marine purposes would bring in an extra income to the cultivators of rubber who are facing a crisis due to the unstable prices of latex. The technology would benefit in saving the precious forest cover. Although the stipulated forest cover of India is 33%, the actual cover is only about20% necessitating lesser deforestation. The new technology would help in maintaining the ecological stability by conserving the fast depleting forest cover. The conventional prime quality boat building timbers are very scarce and have become very costly. Traditional fishermen using wooden canoe find it extremely difficult to afford the cost. The new technology can reduce construction cost of small canoes by 35-40%. The use of rubber wood, which comes as a by- product from the rubber plantations, for marine purposes would bring in an extra income to the cultivators of rubber who are facing a crisis due to the unstable prices of latex.Approximate cost of production for 6.4 m LOATreated Rubber Wood Canoe: Rs. 17,650/- per unit.

FRP coated Rubber Wood Canoe

The technology has made possible the utilization of rubber wood and also provided additional dimensional stability through sheathing. This technology relates to the construction of a low cost, maintenance-free fishing canoe for use by traditional fishermen in the inland water and in the sea. The improvement is that FRP is used as a sheathing material on top of wood for reducing maintenance, preventing attack of marine woodborers, achieving water proofing, preventing decay and helping to provide resistance to impact and abrasion and to improve appearance.

The new technology can reduce construction cost of small canoes by 35-40%. The FRP sheathing

provides water proofing, reduces maintenance, resistance to impact and abrasion and prevents attack of marine borers and other decay causing organisms besides giving an extended service life and better appearance for the wooden canoe. Canoe made of treated rubber wood and sheathed with FRP will give a maintenance-free service life of 15-20 years. The FRP sheathing also provides environmental benefits by way of minimizing the preservatives as well as preventing leakage of chemicals into the water body. The construction is simple and can be taken up by traditional boat builders once a basic training is received. Thus FRP enables the fishermen to make efficient use of the under-utilized rubber wood for small canoe construction. Approximate cost of production for 6.05 m LOA FRP-coated rubber wood canoe: Rs. 27,100/- per unit.

Coconut Wood Canoe

ICAR-CIFT has designed and developed traditional fishing canoe from the coconut wood, which can be used for artisanal fishing like ring seining, gillnetting etc. Coconut wood is an agricultural by product with little or no value to the farmers. Though coconut wood scores higher than many structural timbers in terms of mechanical properties and working qualities, it is not used commonly for boat construction. Canoes were designed based on the dimensions commonly used for fishing boat building in Kerala. The dimensions adopted for building the prototype is 9m LOA, 1.5m breadth and 0.7 m depth. This technology relates to increasing the durability of the low cost coconut wood for marine purposes. This is achieved through treatment of the wood with a chemical preservative viz. Copper Chromium Boron is used for prolonging the life of coconut wood. The preservative treatment increases the durability of wood, prevents bio-deterioration and reduces the cost by 35-40%.The FRP sheathing provides water proofing, reduces maintenance, resistance to impact and abrasion and prevents attack of marine borers and other decay causing organisms besides giving an extended service life and better appearance for the wooden canoe. Canoe made of treated coconut wood and sheathed with FRP will give a maintenance free service life of 15-20 years. The FRP sheathing also provides environment benefits by way of minimizing the preservatives as well as preventing leakage of chemical into the water body. The construction is simple and can be taken up by traditional boat builders once a basic training is received. Thus FRP enables the fishermen to make efficient use of the under-utilized coconut wood for small canoe construction. Approximate cost of production for 9 m LOA FRP-coated Coconut wood canoe: Rs. 1,00,235/- per unit.

Catch loss in gears due to aquatic organisms

Ring seines and gillnets are important artisanal gears usually targeted to catch the shoaling pelagic fishes like sardine, mackerel and anchovies. The operational hazards faced by the artisanal fishers includes, attack of cetaceans, pufferfish bites, entanglement of small fish like ambassids and jellyfish blooms which may enter ring seines. One solution to prevent the cetacean attack in ring seine are Pingers. Pingers are devices that producesultrasound which keep the bottlenose dolphins and porpoises away from the nets. Pinger is designed to work by emitting a sound wave signal beyond70 kHz that is known to be in the best hearing range of most dolphin species. The signal acts as an alarm, and in some cases the pinger stimulates dolphins to use their echolocation which alerts them to the presence of the pingers and fishing nets.

Due to cetacean attack in ring seines an average of 67-180kg of webbings are been replaced annually. The cost of webbing to replace the damaged area in ring seines was estimated to be Rs. 55128 - Rs. 94813. About 7.5-20 man days are lost and the mending charges per day per person are Rs. 800. Hence an average total loss of Rs.61128- Rs. 10813 is estimated. Due to puffer fish bite in ring seines an average of 25-53 kg of webbings are been replaced annually. The cost of webbing to replace the damaged area in ring seines was estimated to be Rs-19995- Rs. 43398. About 3-6 man days are lost and the mending charges per day per person are Rs.800. Hence an

average total loss of Rs.22644 - Rs.48670 is estimated. Cnidarian groups entering the net along with the target fish is another menace faced by the fishers. The was during July, August, September and October. The fishermen lowers the net and allows the jellyfish to escape to prevent tearing of net. This results in loss of targeted fish shoal and fishermen move to fresh grounds. Entanglement of fishes belonging to the family Ambassidae is another problem faced by fishermen operating large meshed ring seines (LMRS) during the monsoon and post monsoon season. When Ambassis is gilled/entangled it requires lot of time and labour for removing each fish from the net. The cost of disentanglement of ambassis in ring seines ranges from Rs. 10500-14000 and the repair cost is estimated to be Rs. 331250. Thus a total cost of Rs. 343500 is estimated as loss due to ambassis entanglement. The rural fisherwomen can be trained in fabrication and mending of fishing gear under the Co - operative sector.

Mechanised Fishing Sector of India

Modern fishing is one of the most energy efficient intensive methods of food production. Motorised and mechanised fishing vessels use fossil fuel combustion as the main source of energy, generating large amount of greenhouse gases (GHG) and leading to irreversible climatic and oceanographic changes. The operation of mechanised and motorised vessels contribute significantly to the generation of GHGs. Modification of the vessel technology, fishing gear modification and adoption of energy saving operational interventions are the three main approaches which can make a visible dent in the efforts to conserve energy during fish harvesting. Some of the modifications to conserve energy in vessel technology are the optimisation of hull, propeller and machinery design. The combined synergetic effect of all the above factors will help in significant reduction in fuel consumption and thereby making fish harvesting more energy friendly, resource specific and hence more greener.

The Fishing Technology Division of ICAR-CIFT developed a 19.75 m LOAmulti-purpose fuel efficient fishing vessel is designed to achieve better fuel efficiency and carry out multiple fishing activities (trawling, gillnetting and long lining) depending on the seasonal availability of species. This vessel has an optimized hull form with a bulbous bow at forward below water line to minimize water and wave resistance at sea. The rare combination of steel for hull and fibre glass reinforced plastic for cabin and wheel house, reduces 8% of the total weight of the vessel. Solar power is utilized for cabin lighting and reduces the electrical load of the vessel. The design and construction is certified by the Indian Register of Shipping.

The unique design, combines the results of the all India survey conducted to gather information regarding the most optimum parameters for a multi-purpose deep sea fishing vessel. A most suitable design developed using the outcome of computational fluid dynamics of the hull and wave resistance at sea. The vessel can sail longer in all fishing seasons due to the multi-purpose fishing operations compared to vessels engaged in single type fishing. The carbon footprint is lower when compared to other classes of fishing vessels. Utilization of solar power for cabin lighting which cuts back the electric load of the vessel.The approximate cost of 20.0 m vessel which could be used for commercial operations will beRs. 1.25 to 1.50 crores.

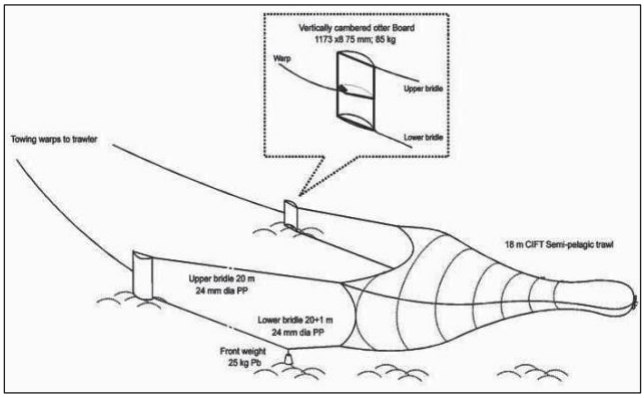
Low drag trawls

ICAR-CIFT designed andfabricated low drag trawls for fish and shrimp ofhead rope length 24.47 m and 3.00 m, respectively.The drag reduction measures included in the designare increased mesh size and new material. Thematerial used is Ultra High Molecular WeightPolyethylene (UHMWPE). As UHMWPE providessame strength at a lower diameter, the twine sizewas reduced which results in reduced twine area.An innovation to significantly reduce drag was high- strength UHMWPE materials that allow the use of thinner twine compared to traditional materials.

Low drag trawls are designed by incorporating drag reduction measures; the identified dragreduction measures are use of knotless netting, Use of thinner twine, use of large mesh, use ofcambered otter boards, optimal angle of attack of otter boards, use of slotted otter boards, use ofmulti-rig trawling and use of pair trawling. Through the study conducted by FTDivision of ICAR- CIFT UHMWPE trawl found to consume 13% less fuel than conventionalHDPE trawls. It is able to make an average increment of Rs. 7,00,000 lakhs in net profit of a 21.33 mtrawler which will be reducing the payback period from 3.04 to 2.62 years.

CIFT Off - Bottom Trawl System (CIFT-OBTS)/ Semi Pelagic Trawl System (CIFT-SPTS)

Trawler fishermen in India cannot depend on shrimp and associated species alone for viable commercial operations any more, and there is a need to adopt responsible alternate trawl systems for harvesting large demersal and semi-pelagic species. CIFT Off - Bottom Trawl System, christened as CIFT-OBTS was developed as an alternative to shrimp trawling in the small-scale mechanized trawler sector, after extensive field-testing. It is capable of attaining catch rates beyond 200 kg h^{-1} in moderately productive grounds and selectively harvest fast swimming demersal and semi-pelagic finfishes and cephalopods, which are generally beyond the reach of conventional bottom trawls, currently used in commercial trawl fisheries in India. CIFT-OBTS has been developed and perfected after extensive field trials and observations, using acoustic gear monitoring instrumentation and inference from statistical evaluation of catch, over an extended period. The system consists of an 18 m four panel semi-pelagic trawl with double bridles, front weights of 25 kg each and vertically cambered high aspect ratio otter boards (trawl doors) of 85 kg each. Its adoption and responsible use will be a boon to the Indian small-scale trawling industry, to enhance fish production and profits and minimize environmental impacts of trawling. Shrimp trawls when operated should be equipped with bycatchreduction devices (BRDs) and should target shrimp alone, in order to conserve fishery resources and minimize biodiversity loss due to trawling. CIFT-OBTS with exchangeable codends (55 mm codend for small demersals like mackerel and horse mackerel and 150 mm codendforall bodied fishes like pomfrets) is prescribed for harvesting non-shrimp trawl resources.



Major advantages of the CIFT-OBTSover the conventional shrimp/fish demersal trawl systems in vogue in Indian Fishing Industry are enumerated below:

Results of performance evaluation and biodiversity analysis have shown that CIFT-OBTS has significantly high resource specificity for off-bottom (semi-pelagic) finfishes, which are generally large in size, fast swimming and exhibit shoaling characteristics. Conventional bottom trawls have poor resource specificity and size selectivity and have greater impact on biodiversity and sustainability.Conventional bottom shrimp and fish trawls have low vertical opening, mostly limited to 1-1.5 m and hence their catches are limited to species living close to the bottom. Due to higher vertical opening up to 4.0 m realized in CIFT-OBTS, resources that are beyond the reach of conventional bottom trawls, could be efficiently harvested.

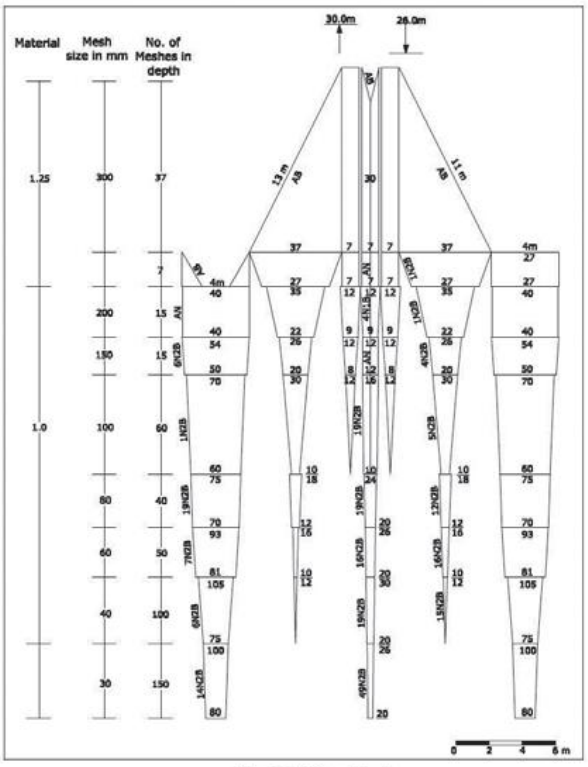
Significantly high sheer-drag ratio of vertically cambered high aspect ratio otter boards makes the system energy-efficient. The vertically cambered high aspect ratio otter boards have dual- purpose capabilities and can also be deployed for conventional bottom trawling. CIFT-OBTSis indigenously developed and is best suited to Indian fishing conditions and fishery resources. The gear system has been developed and optimized taking into consideration the biological, behavioural and distribution characteristics of tropical demersal and semi-pelagic finfish and cephalopod resources and technical capabilities of the small-scale mechanized trawler fleet, operating in Indian waters. About two million tonnes of estimated potential fishery resources in the Indian Exclusive Economic Zone would be accessible to the semi-pelagic trawl system.Approximate cost of production: Rs. 50,000/- per unit

CIFT-Multi Seam Trawl

Bottom Trawling is a very popular fishing method along the east coast of India. Ever since the shrimp catch has been considerably reduced, fishermen have diversified their fishing methods from shrimp trawling to fish trawling. Majority of the fish trawls used in the fishing industry of East coast are two seam trawls which targets bottom fishes causing damage to the sea bed. There is a need to develop diversified fishing practices and alternate responsible trawl systems which are eco-friendly. The CIFT-Multi seam trawl was developed as an alternative to the conventional bottom trawl to target off-bottom fishes and also cause less damage to the sea bottom.

Fishing experiments were undertaken to study the performance of multi seam trawl and its performance compared with a conventional two seam trawl gear in terms of the CPUE and catch composition. The experimental trawl net showed a CPUE rate of 40 kgh^{-1} against 23kgh^{-1} from 2 seam trawl. 0ff -bottom fishes namely ribbon fish, and squid catches were significantly higher in multi seam trawl.

CIFT multi seam trawl is indigenously developed and is best suited to Indian fishing conditions and fishery resources. The gear system has been developed and optimized taking into consideration the biological, behavioural and distribution characteristics of tropical demersal and off-bottom semi-pelagic finfish resources and technical capabilities of the small-scale mechanized trawler fleet, operating in Indian waters. About 4.9 million tonnes of estimated potential fishery resources in the Indian Exclusive Economic zone would be accessible to the multi seam trawl system.

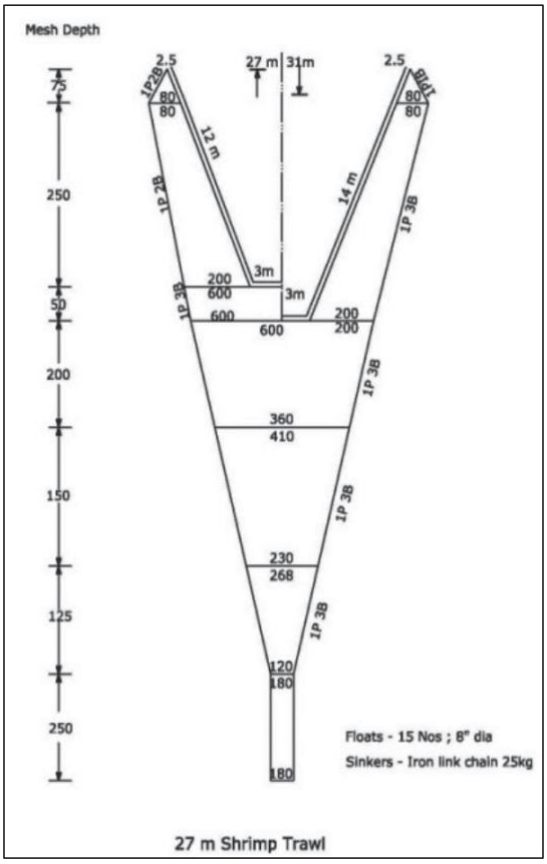


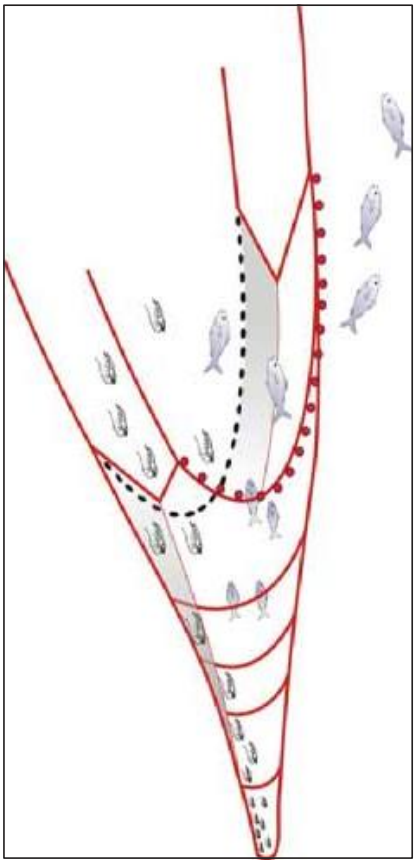
26 m Multi SeamTrawl

The 26 m multi seam trawl is fabricated with 14 seamswith seven panels. The seams are strengthened by supporting ropes. The mouth of the trawl is made with large mesh and the body netting is graduated as it narrows with decreasing mesh sizes of the lighter ranges of nylon twines. System consists of an 18 m four panel semi-pelagic trawl with double bridles, front weights of 25 kg each and vertically cambered high aspect ratio otter boards (trawl doors) of85 kg each.

The multi seam trawl had a relatively higher CPUE than the conventional two seam net and effective in targeting off-bottom fishes. The multi seam trawl can be very useful for the commercial trawlers, along the east coast of India.The net can used for exploring new grounds and also help in reducing the pressure on bottom resources, environmental damage caused due to demersal trawling and help in protecting marine biodiversity, for longer sustainability of fishery resources.Approximate cost of fabrication of Multi seam trawl is:Rs. 8000/- per unit

Short Body Shrimp Trawl



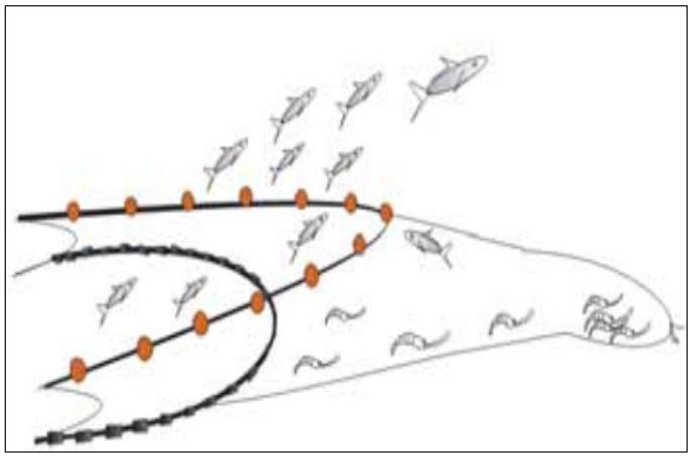


The research team at ICAR-CIFT has developed and successfully field tested a 27 m shrimp trawl with relatively short body and large horizontal spread suitable for selective retention of shrimp during trawling operations from small mechanized trawlers which are popular in India. The length of the trawl body has been considerably reduced by increasing the taper ratio and the vertical opening of the mouth has been reduced to eliminate bycatch which predominantly consists of non-targeted fishes. The relatively better swimming ability of finfishes compared to shrimps help them to counter the short and lower vertical height of trawl and swim out of the net. Because of the larger horizontal spread of the trawl mouth, the effective sweep area is more, which is an important requirement for an efficient shrimp trawl. In addition, the reduction in quantity of netting used in the trawl construction will result in operational fuel savings.

Trials carried out along the coastal waters off Cochin with a prototype of short body shrimp trawl reveals considerable reduction in the fish catch due to the difference in relative swimming speed and vertical distribution profile of shrimp and finfishes. The results indicate that there is a significant reduction in the mean catch per unit effort (CPUE kg h-1) of non-targeted bycatch which reduced from 9.75 kg $h^{-1}$to 2.75 kg.h^{-1}. No significant reduction in the shrimp catch was noticed, when compared to the catches from a commercial trawl design. Since no major investment is needed for adopting this technology, fishermen will adopt the technology as there will be increase in shrimp catch and reduction in bycatch and also reduction in cost of fabrication due to

reduction in the material required. Sorting time is reduced as the catch of non-target species is less and this will also increase the productive tow time and help in fuel saving. Use of selective shrimp trawl nets should be popularized for sustainable fisheries for the long term benefit of conservation of resources and protection of biodiversity.Approximate cost of production for 27 m Short Body Shrimp Trawl: Rs. 22,000/- per unit.

Cut-away Top Belly Shrimp Trawl



A commercial shrimp trawl usually catch large quantity of finfish juveniles as a result of the vertical opening and the square, the front part of top belly. Fishes in the mouth region of the trawl are unable to escape by swimming up due to the top belly cover. ICAR-CIFT has designed and developed a 24 m shrimp trawl without top belly and relatively short body and more horizontal spread. The open belly is to facilitate the escapement of fish component from the shrimp trawl, which is dominated by juveniles and sub-adults. The new design is expected to reduce drag and reduce operating cost. In addition, the reduction in quantity of netting used in the trawl construction will result in operational fuel savings.

Since the top belly is removed actively swimming fishes can escape the trawl by swimming up whereas the shrimp component can be retained as usual. Increased horizontal spread will increase trawl swept area which is expected to increase shrimp catch. More area can be covered within the given time, because of better speed. Drag of the trawl is reduced since the total twine surface area is less which will lead to fuel saving and reduction in the operating cost. The long term benefits of the technology are improvements in economics of trawler operations, protection of biodiversity, resource conservation and sustainable trawl fisheries. The reduction in the quantity of netting used in the trawl construction will result in operational fuel savings.Approximatecost of production for 24 m Cut-away Top Belly Shrimp Trawl: Rs. 22,000/- per unit

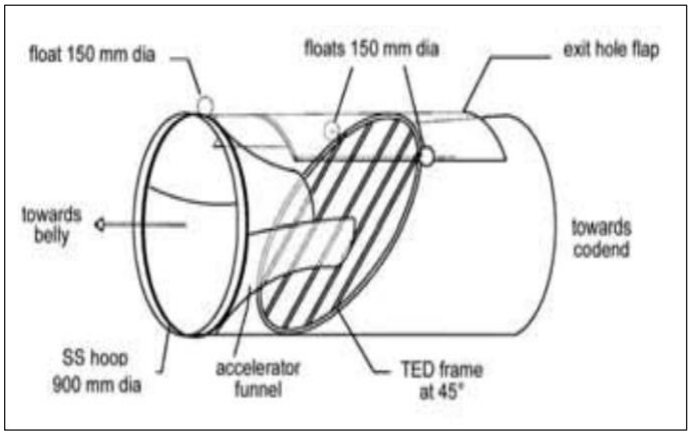
Large Mesh Purse Seine

Purse seining is one of the most efficient and advanced commercial fishing methods. It is aimed mainly at catching dense, mobile school of pelagic fish and includes all elements of searching, hunting and capture. Purse seine nets use mesh sizes ranging from 10 to 22 mm in the

main body of the netting and is mainly for targeting anchovies, sardines and mackerels in the coastal waters. With the objective of targeting the under exploited large pelagic fishes in deeper waters, a purse seine net was designed with large mesh size (45 mm), so as to reduce fishing pressure in the coastal waters. Introduction of large mesh purse seines facilitated by ICAR-CIFT has led to the revival of small mechanized purse seine fishery in Kerala. The changeover of mesh size in the purse seine from the conventional 20 mm to 45 mm has shown good results and the purse seiners has been able to land larger size classes of high value species. Experimental fishing operations carried out from the purse seiner MV Bharat Darshan during the period 2007-2010 in the depth range of 50 to 220 m revealed that the catch mainly comprised of large sized mackerels (62.08%), followed by tunas (16.08%), Pomfrets (1.93%), carangids (14.43%) and miscellaneous fishes (5.47%). All the purse seiners based at the Cochin Fisheries harbour, Kerala have changed over to 45 mm mesh size purse seines and started operations in the deeper waters targeting skipjack tuna, little tunnies, carangids, black pomfrets, horse mackerels, barracudas, seerfish and mackerel.

The traditional fishermen and the purse seiners were targeting small pelagics like anchovies, sardines and small mackerels in the coastal waters. The purse seiners were also targeting the same resource in the coastal waters. There was severe competition and rifts between the traditional and mechanized purse seiners. With the introduction of large mesh purse seine, the fishermen could go to deeper and farther waters targeting large pelagics like tunas, seerfish, pomfrets and large mackerels thus reducing the competition and fishing pressure in the coastal waters.Approximate cost of production: Rs. 18,00,000/- per unit

Bycatch Reduction Devices - CIFT - TED



CIFT Turtle Excluder Device (CIFT-TED)

Field trials with CIFT-TED, so far, has shown a mean catch loss in the range of 0.52-0.97% for shrimp and 2.44-3.27% for non-shrimp resources, which is considerably less than the loss incurred during the operations with imported TED designs. The loss of finfish catch is expected to vary from zone to zone and from season to season, depending on the percentage representation of large finfishes and elasmobranchs in the trawl catch. However, the large species that are excluded due to installation of TED are not lost to the fishery as a whole, as they can be caught by other fishing techniques in vogue in the fishing area.Approximate cost of production: Rs. 4000/- per unit

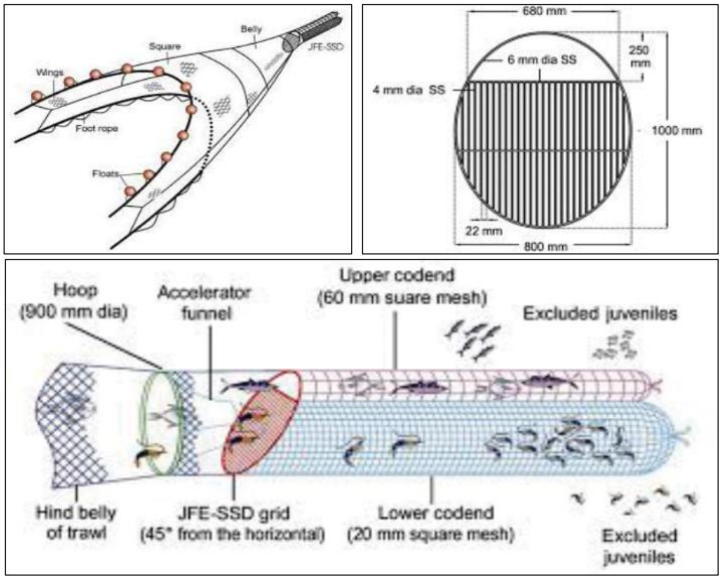
Juvenile Fish Excluder cum Shrimp SortingDevice (JFE-SSD)

The Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) is a Smart Gear (WWF) award winning design developed by ICAR-CIFT which brings down the bycatch of juveniles and small sized non-targeted species in commercial shrimp trawl and at the same time enables fishermen to harvest and retain large commercially valuable finfishes and shrimp species. In addition, the fishermen would benefit economically from higher catch values due to improved catch quality, shorter sorting time, longer tow duration, higher catch and lower fuel costs. Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) replaces the conventional codend of the trawl net. The device consists of an oval grid made of stainless steel rods having bar spacing of 22 mm kept at 45° angle to the horizontal. The grid is provided with a 250 x 680 mm top opening which leads to an upper codend with large square meshes (60 mm). A funnel made of netting (20 mm mesh size) accelerates the flow of water and guides the catch components towards the lower side of the oval grid kept at 45° angle to the horizontal which separates the shrimp from the rest of the catch.

The device reduces the bycatch of juveniles of finfishes, shrimps, crabs and cephalopods, and small sized fishes of less commercial value, contributing to sustainability of the resources and protection of biodiversity. The fishermen are able to retain large fishes of higher market value,

which will enhance the overall revenue realized from trawling operations. Increase in towing time can be expected due to slow filling of the codend as a result of reduction of non-target fishes and juveniles. The in situ sorting effect and separation of shrimps from finfishes and cephalopods help to reduce the sorting time and increase useful fishing time of the trawler fishermen and thus enhance the profitability.

Shrimps pass through the grid spacing and are retained in the lower codend made up of 20 mm square mesh netting. Juvenile shrimps escape through 20 mm size square meshes of the lower codend. The large fishes and cephalopods are deflected upwards to the 250x680 mm wide opening provided at the top of the grid and enter into the upper codend with large square meshes (60 mm). Juveniles of finfishes and cephalopods, and low value small sized finfishes, which have entered the upper codend escape through large square meshes in the upper codend.



JFE-SSD operations off southwest coast of India have realised bycatch reduction up to 42.9% with shrimp retention of about 95%. Out of a total retained catch (in the lower and upper codends), about 77% was retained in the lower codend and the balance in the upper codend. Of the retained catch of non-shrimp resources, about 70% was retained in the lower codend and nearly 30% in upper codend. The sorting effect was most pronounced in the shrimp species. Out of the retained shrimp catch, nearly 99% was retained in the lower codend.

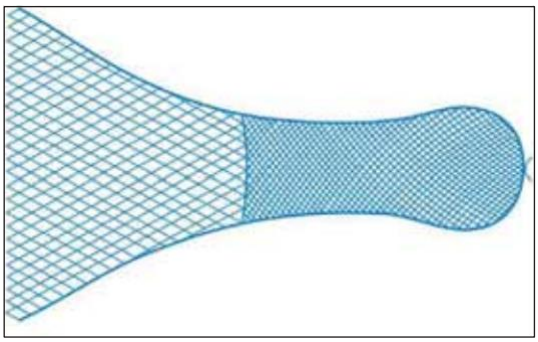
The fabrication cost of the grids: Rs. 6000/-

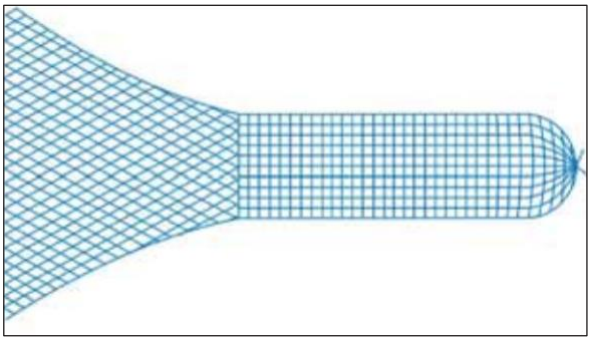
Fabrication of the double codend made of HDPE: Rs. 2000/-

Total cost: Rs. 8000/-

Square Mesh Codend

Traditionally codends are made of diamond shaped meshes, which tend to close during the fishing process and hence make the release of untargeted species in the codend very difficult. The square mesh codends, due to the virtue of its modified rigging, remain open during fishing operations unlike diamond shaped meshes. The open meshes help the juveniles of commercially important species to escape, thereby reducing the quantity of bycatch during trawling operations. Square mesh codends are prepared from diamond mesh webbing by barcuts, rejoining and then strengthening by marling to prevent the unravelling of the meshes.





Use of square mesh codends significantly reduces the bycatch often comprising of the juveniles of commercially important species. Studies carried out by ICAR-CIFT along the Indian coast have recorded an increase of 12-25% in the mean selection length of different targeted species by using square meshes in the codend. Good filtration and reduction in the drag are other benefits of the technology. No significant economic loss is incurred since the escapees are the juveniles which often fetch very less value in the market.

The traditionally used diamond meshes can be converted to square meshes and hence there is no additional cost involved. The cost of one codend can range from Rs. 1500 to Rs. 2500, depending on the design used by fishermen.

Conclusion

The technologies mentioned in the chapter and numerous other technologies can be taken up by small/ medium scale entrepreneurs for starting business in the fishing sector. The infrastructure required for these ventures will not be very high as most of the technologies mentioned can be manufactured at the village level with existing facilities like village boat yards, small workshops etc. Further women fisher folk can be trained in the cutting and fabrication of gears, bycatch reduction devices etc. which will provide an alternate livelihood for the fisher families. As there is a dearth of labour force in the gear fabrication and repair sector skilled women work force would be much in demand.