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RECENT ADVANCEMENTS IN FISH HARVEST SECTOR BY ICAR-CIFT

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With about 171 million tonnes of fish production which peaked at in 2016 globally, aquaculture contributed around 80.3 million tonnes and 90.9 million tonnes through the total capture production (FAO, 2018). Worldwide 59.6 million people engaged fisheries and aquaculture in 2006, out of that 19.3 million people engaged in aquaculture and 40.3 million people engaged in fisheries. In India fisheries sector is promises 14 million employment and income generation. Fishing has been an ancient occupation. It directly contributes approximately 10% of the total animal protein intake by humans. As far as per capita consumption is concerned, global fish consumption is growing at an average rate of about 1.5 percent per year. It was 9.0 kg in 1961 which touched 20.2 kg in 2015. Preliminary estimates for 2016 and 2017 pointed to further growth to about 20.3 and 20.5 kg, respectively (FAO, 2018). India is one of major fish producing countries in the world. It has an Exclusive Economic Zone (EEZ) of 2.02 million sq.km, a long coastline of 8,118 km and two major groups of Islands with rich and diverse marine living resources. The marine fisheries wealth is estimated to have the annual harvestable potential of 4.412 million metric tonnes. In the year 2017-18 the marine fish landings of India was 3.83 million tonnes which is 5.6% more than the preceding year (CMFRI, 2018). There were 1,99,141 fishing vessels operates in marine fisheries sector of India out of which mechanised, motorised and traditional artisanal vessels contributes about 36.5%, 36.9% and 26.6% respectively. Among the mechanized crafts fully owned by fishermen, 29% were trawlers, 43% were gillneters and 19% were dolnetters. Where as in terms of total catch landed during year 2017- 18, mechanized, motorized and artisanal contributed around 75%, 23% and 2% respectively (CMFRI, 2018). Indian marine fisheries resource supports the livelihood of about 4 million people. The increased demand for fish has prompted the development of new harvesting techniques mainly fuel-efficient and resources specific craft and gear and responsible fishing techniques. The recent developments in fish harvesting techniques are briefly reviewed in this chapter. The ICAR-Central Institute of Fisheries Technology (ICAR-CIFT) set up in 1957 is the national institute in the country where research related to fishing and fish processing is undertaken. The institute started functioning at Cochin in 1957. As a contribution to the nation's fishing sector, ICAR-CIFT focuses on basic, strategic

and applied research in developing fuel efficient fishing vessels, responsible fishing gears, designing innovative implements & machinery for fishing, Eco-friendly technologies for responsible fishing and low-energy fishing technologies for the traditional sector. This institute has also been in the forefront of recommending standards for netting, netting yarn and netting twine used for fishing net and standardization of fishing gear accessories.

Fuel efficient fishing vessels

19.75 m fuel efficient multipurpose fishing vessel; Sagar Harita: The fishing vessel, Sagar Harita, a 19.75 m long fuel efficient multipurpose fishing vessel designed by Fishing Technology Division of ICAR-CIFT and built by Goa Shipyard Limited (GSL). The vessel has met all the requirements of the Indian register of shipping (IRS) and ICAR-CIFT. This new generation energy efficient green fishing vessel is equipped with the latest technology solar panels, aiming to promote green energy and reduce the carbon foot prints. The solar panels fitted on the vessel cater the energy requirement for navigational lights, cabin lights etc. The vessel also incorporates an optimized hull design with a bulbous bow, fuel efficient propeller design and improved sea keeping characteristics. Modern tools and techniques including software simulation and model testing have been used for the refinement of the design. The ship's super structure above deck level has been made from FRP using the latest 'resin infusion technology' thereby significantly enhancing the sea keeping performance.

F V Sagar Haritha (LOA 19.75m, fuel efficient multipurpose fishing vessel)

15.5 m deep sea fishing vessel; Sagar Kripa: ICAR-CIFT has taken initiative to develop fuel efficient fishing vessels in view of high expenditure incurred in mechanised fishing operations. A 15.5 m multi-purpose deep sea fishing vessel Sagar Kripa with steel hull was designed and developed with energy saving features. These include optimized hull design, optimized installed engine power, fuel efficient propeller and propeller nozzle. The commercial trials by the fishing boat operators have saved about 17% of the fuel cost.

Energy saving trawling technologies

Trawling is an active fishing method in which a bag shaped fishing gear is towed from mechanized fishing vessel. It is known to be one of the most energy intensive fishing methods.

Low drag trawls: In excess of 60% of the total resistance in the trawl system is known to be contributed by netting alone. Fuel consumption during trawling is directly related to the drag of the gear system. Substitution of large meshes in the front trawl sections has been reported to reduce the drag of the trawl system by about 7% and hence reduces fuel consumption in trawling. The reduced drag permits greater trawling speed and/or operation of larger trawl with the available installed engine power. Large mesh demersal trawls, have been extensively adopted by mechanized fishermen of north-west coast, Mangalore and Kerala, for resources like Ribbonfish, Squid, Horse Mackerel, Mackerel and Pomfrets, due to its low drag and fuel efficiency. Fuel cost alone constitute up to 75% of operational expenditure. Drag offered by trawl depends on factors like design and rigging of the net alone contributed 58% of the total drag offered by a trawl. Estimation of drag of commercial trawls in Kerala reveal that it ranges from 1.5 to 49.0 kN according to the design used. Adoption of optimised towing speed, thinner twines and large mesh to reduce twine surface area are found to bring down the drag and hence the fuel consumption. Conventional trawls made of HDPE are with more drag due more twine surface area and weight of webbing. Ultra High Molecular Weight Polyethylene is a stronger material compared to HDPE, which permit to use thinner twine for trawl fabrication. Trials of 24 m UHMWPE low drag trawl developed by ICAR-ICAR-CIFT revealed that average reduction of drag was 15% with 13% average reduction in fuel consumption and average 7.5% reduction in operational expenditure compared to HDPE trawls.

Double Slotted V form otterboards : Experiments onboard CIFT research vessel and commercial vessels revealed that depending on the sea conditions 2-3 liters of diesel can be saved per hour of trawling, compared to the existing boards of same dimensions. The new technology has been readily accepted by the trawl owners and several trawlers in Kerala, Tamil Nadu and Karnataka have already started using the new otter boards. About 20 million liters of diesel can be saved annually in India if all the medium and large category trawlers adopt this technology. Further it helps to improve the income of fishermen and also reduce the emission greenhouse gases, which are the two most important needs in the fisheries sector globally.

V Form Double Slotted otter boards

Cambered otter boards: Otter boards are known to contribute 20-25 % of the total drag of the trawl system. Introducing camber in otter board design is known to reduce resistance of the boards considerably, by increasing the hydrodynamic efficiency of the boards. ICAR-CIFT has introduced high aspect ratio, cambered otter boards for semi-pelagic trawling. Introduction of camber in otter boards reduces the drag of the trawl system by 4% with accompanying savings in fuel.

Cambered steel otter boards

V-form otter boards: The V-form otter boards are hydrodynamically efficient and have very inherent stability. It is made of steel and do not utilize wood in their constructions. These boards do not plough or dig into the bottom and will tide over smaller bottom obstacles, thus becoming suitable for trawling in uneven and rocky grounds. V-form boards are cheaper and safe in shooting and hauling if properly rigged with a longer service life of 5-6 years. V-form type otter boards have become popular among trawler fishermen of southern India and Gujarat, since its introduction.

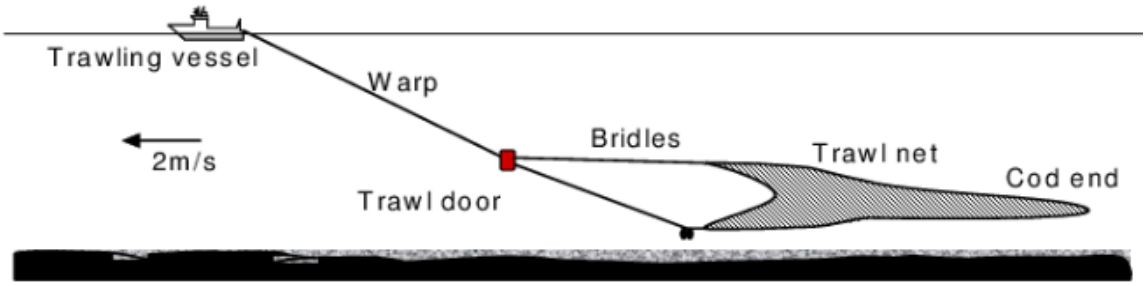
V Form otter boards

Low energy and eco-friendly harvest technologies for the inland fisheries and traditional marine sector

ICAR-CIFT Collapsible Fish Trap: ICAR-CIFT improved the design of traditional trap as collapsible fish trap (1 m×0.6 m×0.6m) with two rectangular and square frames with stainless steel. HDPE webbing of 80 mm mesh size is used as cover of the trap to allow fish to enter. Two entrance funnels made of plastic mesh are fixed on both sides. These traps were supplied to local fishermen and experimental trials were conducted along backwaters of Vypeen Island, Kumbalangi, Cheranellor and Varapuzha. Etroplus suratensis, Lutjanus argentimaculatus, Lates calcarifer, Epinephelus sp, Scylla serrata are the common target species and the trap can be set and hauled after 2-3 days of soaking. Average catch/haul is 1.5 kg. Design of the trap is simple and any fishermen can adopt the technology and is 40% lighter in weight and durability is 3- 4 times more than the conventional traps. Cost of ICAR-CIFT collapsible fish trap is only 50% of the conventional bamboo traps with same dimension. ICAR-CIFT collapsible fish trap will be a better option for the traditional fishermen to improve the livelihood.

Myctophid trawl (28.4 m & 45 m): Myctophids are the most abundant group of mesopelagic fishes in the Indian Ocean. About 137 species of myctophids are reported in the Indian Ocean. About 75% of total global catch of mesopelagic fishes is accounted by myctophids. Two mesopelagic trawls (28.4 m and 45m) with four equal panels were designed and operated from FORV Sagar Sampada and ICARCIFT research vessel R.V. Matsyakumari-II. Estimated trawl drag for 45 m trawl in terms of towing speeds of 2to 3kn range from 4.9 to 7.3 t. The new mid-water trawl system designed to attain largermouth area, smoothly tapering trawl body with small meshes in belly and codend, which can be towed at about 2.5 kn is adjudged to be appropriate, taking into consideration available information on biological characteristics and behavior of myctophids, fishing conditions and vessel characteristics.

ICAR-CIFT Off-bottom Trawl System (OBTS): Trawler fishermen in India cannot depend on shrimp and associated species alone for viable commercial operations any more, and there is need to adopt responsible alternate trawl systems for harvesting large demersal and semi-pelagic species. ICAR-CIFT 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. ICAR-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.



Representation of ICAR-CIFT Off-bottom Trawl System (OBTS)

Large mesh gillnet and monofilament long lines in Lakshadweep: Appropriate craft designs and improved gear designs such as optimised gill nets, lines and traps have been developed and introduced for the inland fisheries. Improved and durable lobster traps with escape window for juveniles have been developed as substitute for traditional traps of short life span and low efficiency, for harvesting of spiny lobster. The rich tuna resources of the Lakshadweep waters are under-exploited as the fishing operations are still limited to traditional pole and line method. ICAR-CIFT has introduced large mesh gillnets and monolines (monofilament long lines) in Lakshadweep waters, for targeted fishing of Tunas, Billfishes, Seerfishes, Carangids and Perches, in an effort to diversify fishing methods and improve catching efficiency.

Large mesh purse seine and power block for purse seine operations: 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. Introduction of large mesh purse seines facilitated by ICARCIFT 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. The traditional fishermen and the purse seiners were targeting small pelagic 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 tradition and mechanized purse seiners. With the introduction of large mesh purse seine, the fishermen could go to deeper and farther waters targeting large pelagic like tunas, seer fish, pomfrets and large mackerels thus reducing the competition and fishing pressure in the coastal watersExperimental fishing operations carried out from the purse seiner Bharat Darshan during the period 2007-10 in the depth range of 50 to 220 m revealed that the catch mainly comprised of large sized mackerels (62%), followed by tunas (16%), carangids (14%), miscellaneous fishes (6%) and pomfrets (2%). All the mechanised 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.

Bycatch Reduction Devices (BRDs) for responsible fishing and sustainable resources

BRDs for trawls: Among the different types of fishing, trawling accounts for the highest rate of bycatch along with the target species. Almost 70-90% of the trawl catch is bycatch, among which, about 40% is constituted by juveniles that are invariably discarded resulting in two serious consequences- depletion of the resources and pollution of the marine water and the consequential threat to the ecosystem. Further, higher the quantum of bycatch the less will be the economic benefit accruing from the fishing operation. Bycatch is unavoidable in any fishing operation; only its quantities vary according to the type of the gear and its operation. Therefore, one of the important research focuses of the Fishing Technology Division was development of bycatch reduction devices. Bycatch reduction device (BRD) is a device aimed at reducing the catch of non-targeted and unwanted species of fish in shrimp trawling. While BRD is a broad term used to describe any device that can be employed to eliminate or reduce the bycatch, turtle excluder device (TED), though in principle a BRD, is a specialized form of BRD designed to eliminate turtles, sharks and rays also from the trawl. These devices have been designed and developed taking into consideration the differential size and behaviour pattern of shrimp and fish inside the net. BRDs include Fisheye which is stainless steel escape chute attached in the codend for the escape of actively swimming finfishes and rigid grid devices; and soft BRDs such as square mesh windows, Bigeye, Sieve net and International Award winning design Juvenile Excluder cum Shrimp Sorting Device (JFE-SSD) which have been evaluated and recommended for use in Indian waters. Various protection measures have been adopted the world over, including India, for its protection. ICAR-CIFT has developed an indigenous design of the turtle excluder device which is appropriate for the Indian conditions. ICAR-CIFT-TED is a single grid hard TED with top opening of 1000x800 mm grid size for use by small and medium mechanized trawlers operating in Indian waters. In the TED developed by ICAR-CIFT, great care has been taken to ensure 100% escapement of the turtles while escapement of fish and shrimp at the minimum possible level

Low-cost substitutes for conventional craft materials

Traditionally, wood is used for construction of fishing vessels in India which has become scarce and costlier. Focused attention has been given in identifying alternate materials for fishing vessel construction, in order to reduce the dependence on traditional scarce wood species. Cheaper and readily available cultivated wood species with short life cycle such as rubber wood, fortified with dual preservative treatment using 7.5% ASCU and creosote, has been identified for construction of canoes operated in backwater and coastal fisheries. A number of preservative treated rubber wood canoes have been distributed for field operations by fishermen groups and cooperatives. The cost of the canoe is 35 – 40% less than a canoe of same size built of 'Anjili', the usually used wood. This saves the depleting forest wealth, helps the rubber farmer to get a better price for his underutilized wood and gives a durable, maintenance free boat at affordable cost to the poor fisherman especially of the South West

and North East where rubber trees are grown. Designs of fiberglass crafts have been developed for operation in inland waters. Fibreglass sheathing as protection against borer attack and biodeterioaration and as preventive against environmental pollution while using preservative treated wood in boat construction has been popularized, in traditional sector. Use of Aluminium alloy for construction of inland and coastal fishing craft has been demonstrated. Durability, light weight, corrosion resistance, toughness and resilience, low maintenance and high re-sale value make aluminum alloy a good material for construction of fishing craft.

Treated Rubber Wood Canoe: Central Institute of Fisheries Technology has evolved a simple technology for development of traditional fishing canoe from the 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. 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%.

FRP-Sheathed Rubber Wood Canoe: ICAR-Central Institute of Fisheries Technology has developed a fibre glass reinforced plastic

(FRP) sheathed rubber wood canoe for operation in marine and inland waters. The rubber wood, which comes as a waste from rubber plantations is upgraded through chemical preservative treatment and the canoe made using the treated wood is further given a sheathing of FRP. The technology has made possible the utilization of rubber wood and also provided additional dimensional stability through sheathing. 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.

Nano Cerium oxide, Titanium oxide & Iron oxide coating for corrosion resistance in boat building steel: BIS 2062 carbon steel is extensively used for fishing boat construction and is highly susceptible for corrosion in the hull, welding joints and coating failures under marine environments. This technology demonstrates the application of novel multifunctional nano metal oxide mixtures comprised of iron, titanium and cerium as marine coating to prevent corrosion. The electrochemical performance of nano metal oxide mixture coatings, applied over boat building steel, was evaluated inNaCl medium. The thin film surface coatings showed an efficient corrosion resistance with increased polarization resistance and low corrosion current density. The electrochemical impedance spectral data exhibited the improvement in the polarization resistance of outermost surface and internal layers. The coating responded

faster recovery to normal state when subjected to an induced stress over the coating. The nano material in the coating behaves as a semiconductor; this enhanced electronic activity over the surface of the steel. The photo oxidation behavior of Fe2O3 and TiO2, deter the microbial attack

Biofouling resistant polyethylene cage aquaculture nettings: A new approach using polyaniline and nano copper oxide: Biofouling in aquaculture cage nets causes occlusion of mesh openings, thereby increasing weight and drag, deformation of cages due to the ensuing stress, reduction of volume, thereby decreased stocking density per area, anoxic condition due to disruption of dissolved oxygen flow, blocking of food waste diffusion, restriction of water exchange, increased hydrodynamic force, all of which adversely impacted fish health. It has been reported that removal of fouling from a cage net costs 25% of the total project budget. Cages are fabricated mainly with high density netting whose non polar nature makes incorporation of antifouling biocides difficult. The surface of polyethylene needs to be modified to develop strategies against fouling. The novel approach employed by ICAR-CIFT was to synthesise a coating of polar or conducting molecule over non-polar polyethylene to incorporate antifouling biocides thereby rendering protection to protect the polyethylene aquaculture cage nets from biofouling.

Use of advanced fish finding and navigation techniques

Recent advances in technology have provided fishermen with equipment to reach the potential fishing ground accurately (Global Positioning Systems), detect the presence of fish acoustically (echosounder and sonar), thus saving the search time and fishing time and hence saving energy. These advances in technology have been popularized among fishermen, in collaboration with agencies like MPEDA and Department of Fisheries, for bringing down fuel use and environmental impact through fuel use. This, coupled with affordability and subsidy support, has resulted in significant penetration of GPS and Echosounder among small mechanized commercial fishermen, all along the coast.

Fishing craft and gear materials

Various cost effective protective measures against bio deterioration of wooden fishing vessels have been developed and are in use. Use of low cost timber like rubber and coconut have also been experimented successfully for small canoes. In India, ICAR-CIFT which plays a major role in the development of harvest technologies has also developed aluminium alloy sheathing for wooden fishing vessels, cathodic protection against marine corrosion in fishing boats, new substitutes for propeller material for cost savings, marine anti-corrosive paints, marine antifouling paints, chemical wood preservatives, indigenous resin based protective coatings for wooden crafts, ferrocement for boat building, rubber wood canoes, fibreglass reinforced plastic coated fishing canoes. Primarily, mechanized boats were using local gear. Major advances in fibre technology, along with the introduction of modern gear materials, have directly influenced

and brought about important changes in the design, dimensions and method of handling fishing gears. Extensive use of synthetic materials like PA, PE and PP have perceived in 1960s which created a revolution in fabrication of fishing gears. Today, the entire fisheries sector uses only synthetic fibers for gears. Twisted netting yarns and braided netting yarns of different sizes are available in the country. Combination rope of Polyethylene and Polypropylene (Danline) and Polyamide monofilament is being extensively used as an import substitute for tuna and shark longlines. The development of combination wire rope as an import substitute for deep-sea fishing is a recent innovation which has now been commercialised. ICAR-CIFT has standardised specifications for the use of polypropylene multifilament netting yarn with lower specific gravity and better tenacity than nylon (Silas, 2003; Meenakumari, 2011).

Conclusion

In recent years, the developments in harvest technologies in fisheries sector have taken place rapidly. ICAR-Central Institute of Fisheries Technology has contributed greatly to the revolution of fishing industry as well as technology diffusion programmes in a very significant way in the fisheries sector across India. While the fisheries sector is facing challenges in terms of excess capacity of fleet, diminution of fish resources and degradation of the fisheries environment in the coastal waters. The under-utilised and resources in the deeper waters hold potential along with rapid expansion envisaged. It's very imperative to have appropriate technology for application of resource conservation in the shelf waters under an appropriate management plan and diversification of fishing to unconventional resources such as mesopelagics, oceanic cephalopods and large pelagics in the deeper waters. Minimisation of harvest and post-harvest losses, development of technologies for reducing carbon and ecological footprints in the harvest sectors are areas which need focussed attention. Today fisheries sector is watched by many as a sunrise sector as it helps in alleviating food security as well as supports many auxiliary sectors. ICAR-CIFT has major contributions for this transformation. Over the years institute has carried out research on harvest and post-harvest aspects of fish extensively based on the sectors need and developed many ready-to-transfer technologies. Notable ones in harvest sector include design and construction of fishing vessels, eco-friendly fishing gear, satellite-based imaging systems to locate fishing grounds, and automated fish hauling systems. The research information generated is transferred to the end users by adopting suitable extension methodologies

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