Responsible Fishing, FAO-Code of Conduct for Responsible Fisheries and ICAR-CIFT's Initiative

Dr. Leela Edwin
Principal Scientist & Head, FT Division, ICAR-Central Institute of Fisheries Technology, Kochi - 682 029
Email: leelaedwin@gmail.com

What is Responsible Fishing?

The NOAA (National Oceanic and Atmospheric Administration) of the USA clearly defines the concept of responsible fisheries. "Responsible fisheries encompasses the sustainable utilization of fishery resources in harmony with the environment; the use of capture and aquaculture practices which are not harmful to ecosystems, resources, and their quality; the incorporation of added value to such products through transformation processes meeting the required sanitary standards; the conduct of commercial practices so as to provide consumers access to good quality products" (Blackhart *et. al.*, 2006). According to FAO, this concept encompasses the long-term sustainable utilization of fishery resources in harmony with the environment and the use of capture and aquaculture practices that are not harmful to ecosystems, resources or their quality (FAO, 1999). In seafood the term 'responsible sourcing' usually refers to responsible fishing – in other words fishing responsibly for wild-caught fish. Since, there are many types of fisheries and many fish species, the range of factors influencing what is 'responsible' practice can vary greatly (SEAFISH, 2015).

Code of Conduct for Responsible Fisheries

Fisheries and aquaculture are important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world and so more than 17O members of the Food and Agriculture Organization of the United Nations (FAO) adopted the Code of Conduct for Responsible Fisheries in 1995. The purpose of the Code of Conduct for Responsible Fisheries is to facilitate structural adjustment so that fisheries and aquaculture are developed in a comprehensive and balanced manner under the concept of "responsible fisheries". The Code is voluntary rather than mandatory, and aimed at everyone working in, and involved with, fisheries and aquaculture, irrespective of whether they are located in inland areas or in the oceans. Because the Code is voluntary, it is necessary to ensure that all people working in fisheries and aquaculture commit themselves to its principles and goals and take practical measures to implement them.

The Code of Conduct, which consists of a collection of principles, goals and elements for action, took more than two years to elaborate. It is therefore a result of effort by many different groups involved in fisheries and aquaculture. In this respect the Code represents a global consensus or agreement on a wide range of fisheries and aquaculture issues (FAO, 1995).

Objectives of the Code

The objectives of the Code are to:

- Establish principles, in accordance with the relevant rules of international law, for responsible fishing and fisheries activities, taking into account all their relevant biological, technological, economic, social, environmental and commercial aspects;
- Establish principles and criteria for the elaboration and implementation of national policies for responsible conservation of fisheries resources and fisheries management and development;
- Serve as an instrument of reference to help states to establish or to improve the legal and institutional framework required for the exercise of responsible fisheries and in the formulation and implementation of appropriate measures;
- Provide guidance which may be used where appropriate in the formulation and implementation of international agreements and other legal instruments, both binding and voluntary;
- Facilitate and promote technical, financial and other cooperation in conservation of fisheries resources and fisheries management and development;
- Promote the contribution of fisheries to food security and food quality, giving priority to the nutritional needs of local communities;
- Promote protection of living aquatic resources and their environments and coastal areas;
- Promote the trade of fish and fishery products in conformity with relevant international rules and avoid the use of measures that constitute hidden barriers to such trade;

- Promote research on fisheries as well as on associated ecosystems and relevant environmental factors; and
- Provide standards of conduct for all persons involved in the fisheries sector.

World Fisheries: World per capita fish supply reached a new record high of 20 kg in 2014 (FAO, 2016). An estimated 56.6 million people were engaged in the primary sector of capture fisheries and aquaculture in 2014, of which 36% were engaged full time, 23% part time, and the remainder were either occasional fishers or of unspecified status. The total number of fishing vessels in the world in 2014 is estimated at about 4.6 million, very close to the figure for 2012.

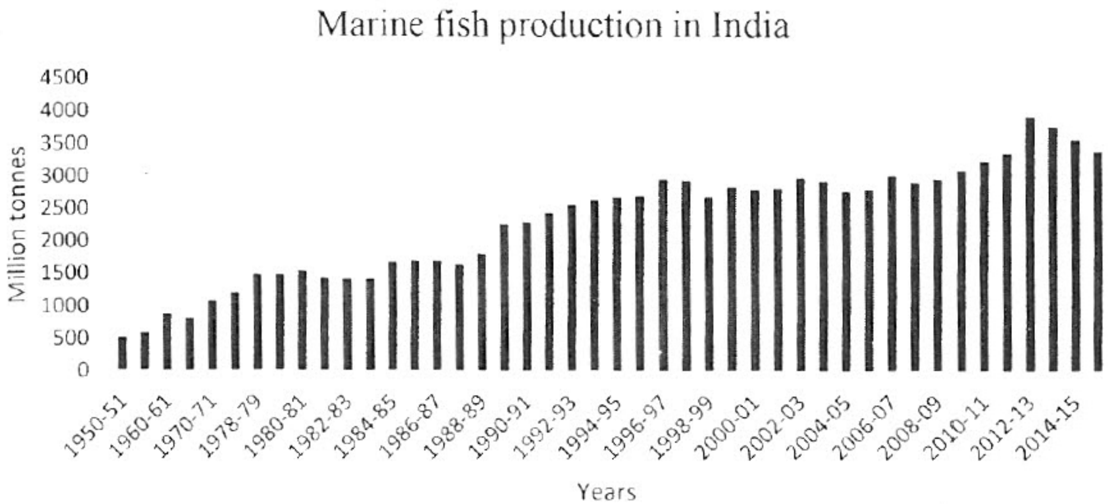


Fig. 1. Total fisheries production of India from 1950 to 2015 (Source: Hand Book of Fisheries, 2015)

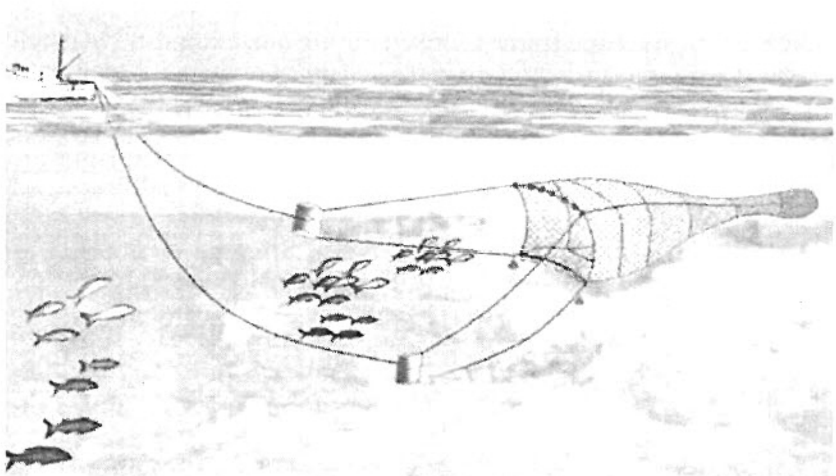
The fleet in Asia was the largest, consisting of 3.5 million vessels and accounting for 75% of the global fleet, followed by Africa (15%), Latin America and the Caribbean (6%), North America (2%) and Europe (2%). Globally, 64% of reported fishing vessels were engine-powered in 2014, of which 80 percent were in Asia, with the remaining regions all under 10 percent each. Global total capture fishery production in 2014 was 93.4 million tonnes, of which 81.5 million tonnes from marine waters and 11.9 million tonnes from inland waters (FAO, 2016a). Marine fish production of India which was only 0.5 million t in 1950, increased to 3.40 million t in 2015 (CMFRI, 2015). This could be attained due to the introduction of various improved fish harvesting systems in India. Figure.1 depicts the trend in total fisheries production of India from 1950 to 2015.

The pelagic resources had been the major contributor in Indian fishery. It has maintained the same status in 2015 accounting 53% of the total landings. This was followed by demersal (28%), crustacean (12%) and molluscs (7%). The three sectors namely mechanized, motorized and non-motorized contributed 75%, 22% and 3%, respectively to the total landings. Of the nine maritime states and two union territories, Gujarat topped in landings with 7.22 lakh tonnes (21.2% share of the total), followed by Tamil Nadu with 7.09 lakh tonnes (20.9%) and Kerala with 4.82 lakh tonnes (14.2%) (ICAR-CMFRI, 2016). The southwest region comprising the states of Kerala, Karnataka and Goa where oil sardine was abundant, experienced a major decline resulting in the overall reduction of oil sardine landings in the country. Other resources shown decline in landings are non-penaeid shrimp by 0.34 lakh tonnes, ribbonfishes 0.32 lakh tonnes, silverbellies 0.27 lakh tonnes and soles 0.09 lakh tonnes. Increased landings were observed in perches by 0.83 lakh tonnes, lesser sardines 0.49 lakh tonnes, scads 0.25 lakh tonnes, cuttlefish 0.23 lakh tonnes and lizardfishes 0.23 lakh tonnes (ICAR-CMFRI, 2016). The river system of the country comprises 14 major rivers (catchments >20,000 km^2), 44 medium rivers (catchments 2,000 to 20,000 km^2) and innumerable small rivers and desert streams (catchments area <2,000 km^2). Different river systems of the country, having a combined length of 29,000 km, provide one of the richest fish genetic resources in the world. Studies have been undertaken for conservation of fishery resources in the inland sector through provision of new materials for craft and gear in rivers and reservoirs. New designs of fishing craft made of FRP, optimie gears for sustainable harvesting has been popularise by ICAR-CIFT.

Responsible fishing for resource conservation Responsible Fishing Gear

ICAR-CIFT has been in the forefront of developing technologies for responsible fishing and fisheries conservation.

Eco-friendly trawls: Demersal trawls are generally non-selective and a large number of non-target species and juveniles are landed during trawling, in addition to its impact on benthic communities. Resource-specific trawls for semi-pelagic resources have comparatively low impact on the benthic biota. ICAR-CIFT Off Bottom Trawl System (CIFT-OBTS), otherwise known as the off bottom trawl system has been developed as an alternative to shrimp trawling in the small-scale mechanized trawler sector, after extensive field-testing. The system consists of an 18 m four panel semi-pelagic trawl with double bridles, front weights and vertically cambered high aspect ratio otter boards of 85 kg each. 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



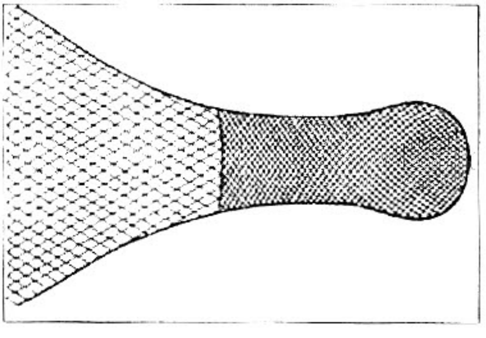
Eco-friendly off bottom trawl system

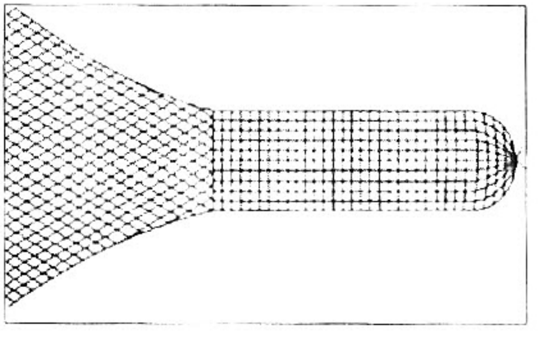
finfishes and cephalopods, which are mostly beyond the reach of conventional bottom trawls, currently used in commercial trawl fisheries in India.

Selectivity of fishing gears: Information on fishing gear selectivity is important in biological investigations, fish stock assessment, fisheries management and for fishing gear design and development. Selectivity characteristics such as mean selection length, selection range, selection factor and selection curve of square mesh and diamond mesh with respect to demersal catch components have been determined through covered codend experiments.

Bycatch Reduction Technologies: Among the different types of fishing, shrimp trawling accounts for the highest rate of bycatch, of which a significant portion is constituted by juveniles that are generally discarded. 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 and only its quantities vary according to the type of the gear and its operation. Therefore, one of the important areas of research of the Institute has been the development of bycatch reduction technologies. Devices developed to exclude the endangered species like turtle, and to reduce the non-targeted species in shrimp trawling are collectively known as Bycatch Reduction Devices (BRDs). These devices have been developed taking into consideration variation in the size, and differential behaviour pattern of shrimp and other animals inside the net. BRDs can be broadly classified into three categories based on the type of materials used for their construction, viz., Soft BRDs, Hard BRDs, and Combination BRDs. Soft BRDs make use of soft materials like netting and rope frames for separating and excluding bycatch. Hard BRDs are those, which use hard or semi-flexible grids and structures for separating and excluding bycatch. Combination BRDs use more than one BRD, usually hard BRD in combination with soft BRD, integrated to a single system. Oval rigid grid BRD, Fish eye BRD, Big eye BRD, Sieve net BRD which have given bycatch exclusion rates of 11-63% with an accompanying shrimp loss of 1-8%, have been recommended for shrimp trawls, for bycatch reduction and protection of juveniles. Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) is a Smart Gear award winning design (WWF) developed by ICAR-CIFT for protecting juveniles and for pre-sorting of the catch (Boopendranath *et. al.*, 2008; WWF, 2009).

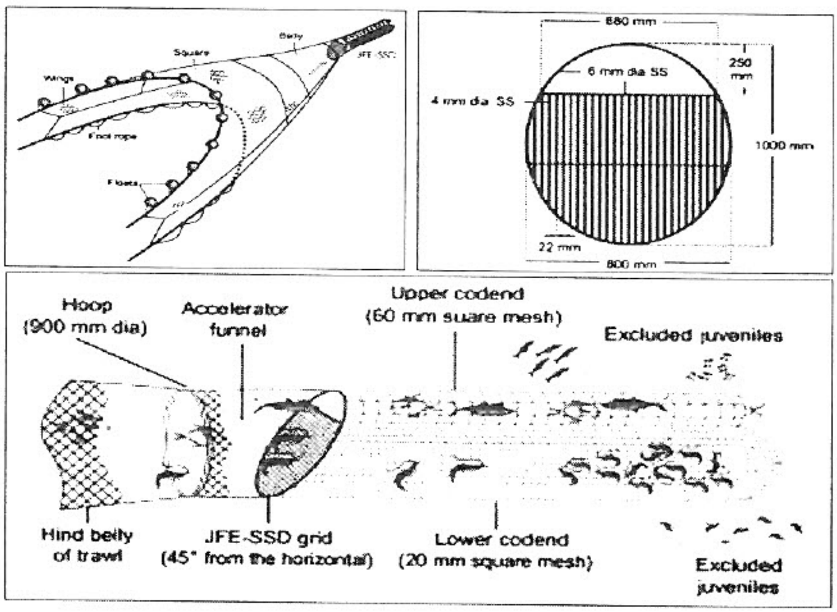
Square mesh codend: ICAR-CIFT has for long been advocating the use of square meshes for trawl codend as a conservation measure. As the meshes in the square mesh codends remain open under tension during trawling, water flow will not be restricted and filtration will be efficient and resultant drag will be comparatively less which minimizes fuel consumption. As the mesh lumen remains open, it is easy for small fishes and juveniles to escape through the meshes which reduces the quantum of bycatch enabling the conservation of aquatic resources.





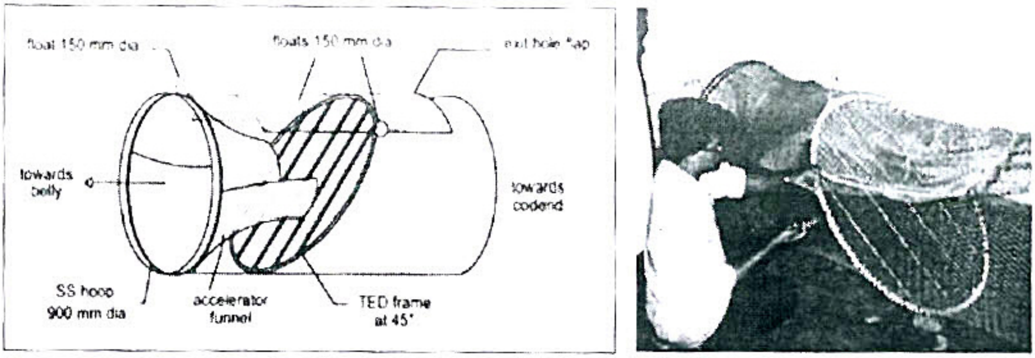
In addition to these benefits, the quantity of net required for fabricating square mesh codend is less than the requirement for diamond mesh codend of the same dimensions, resulting in lower fabrication costs. As per ICAR-CIFT recommendations, Gujarat Marine Fishing Regulation Act (GMFR Act-2003) has prescribed the use of 40 mm square mesh codends in the trawl nets. The use of square meshes have been successfully demonstrated by ICAR-CIFT in the Sindhudurg District of Maharashtra under a UNDP – GEF project. Most recently the Govt. of Kerala has adopted 35 mm square mesh codend for fish trawl and 25 mm codend for shrimp trawl through amendment of the Kerala Marine Fisheries Regulation Act.

Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) Trawl fishermen in India and other tropical fisheries depend on both finfish catches and shrimp catches to keep the commercial operations economically viable. ICAR-CIFT has developed a unique solution for this issue by developing Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD), which retains mature shrimp in the bottom portion of the net while allowing juvenile shrimp to swim out through the mesh unharmed. The device also retains mature finfish in the upper codend of the device, while allowing small sized fish of low commercial value and juveniles of commercial species to be safely excluded. JFE-SSD has bycatch exclusion rate of 43% with a shrimp retention of 96-97%. The



sorting of the shrimp and the finfish between the lower and upper parts of the net enhances profitability because it reduces sorting time on the deck which increases the useful fishing time of the trawler fishermen, and it prevents shrimp from becoming crushed under the weight of fish and bycatch hauled on deck which increases the shrimp's market value.

Turtle Excluder Device (TED) Sea turtles are endangered species. Incidental catches of turtles have been reported in the trawl landings of India particularly from West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and southern parts of Kerala. ICAR-CIFT has



Turtle Excluder Device (TED)

developed an indigenous design of the turtle excluder device which is appropriate for the Indian conditions. 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 exclusion of fish and shrimp is at the minimum possible level. MPEDA, Kochi has adopted the technology and distributed about 2900 CIFT-TEDs to trawler fishermen and operators in states affected by sea turtle mortality, *viz.*, West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Kerala. Demonstration cum training on Fabrication, installation, operation and maintenance of CIFT-TED were conducted at several centres in West Bengal, Odisha, Andhra Pradesh and Kerala, in collaboration with MPEDA, Department of Fisheries, Department of Wildlife and NGOs.

Bycatch reduction in gillnets, purse seines, hooks and lines, and traps Bycatch in drift gillnets may include marine mammals, sea turtles and sea birds, in addition to non-targeted fish species. Optimisation of gillnet mesh size and hanging coefficient according to the target species and size group and judicious deployment of gillnet in terms of fishing ground, fishing depth and season in order to minimize the gear interaction with the non-targeted species are important bycatch mitigation measures for gillnet fisheries. One approach to minimize ghost fishing by lost gillnets, is to use biodegradable natural fibre twines or time release elements to connect the netting to floats (Hameed and Boopendranath, 2000). Bycatch incidence in purse seine is said to be mostly due to accidental pursing of juvenile shoals.

Selection of mesh size for the purse seine appropriate for the target species, proper choice of fishing area, depth and season could also lead to better selectivity of purse seines. Special escape panels known as Medina panels, which are sections of fine mesh that prevent dolphins from becoming entangled in the gear, and back down manoeuvre have been deployed to prevent capture of dolphins in purse seines (Ben-Yami, 1994). Optimized hook design and size and selection of bait type and bait size appropriate for the target species and size class, proper choice of fishing ground, depth and time of fishing are approaches for mitigation of bycatch issues in hook and line fisheries and minimise gear interaction with other species. Optimized trap design according to the target species and provision of escape windows for juveniles and non-target species in the design side and appropriate choice of bait type, fishing area, fishing depth, fishing time also help to minimize juvenile catch in traps.

Responsible fishing for energy conservation Motorized and mechanized fishing operations are dependent on fossil fuels, which are non-renewable and limited. Fossil fuels produces increased levels of carbon dioxide in atmosphere contributing to green house effect and other pollutants which are detrimental to the environment and human health. Green house effect leads to irreversible climatic and oceanographic changes. Moreover spiraling oil prices may severely affect the economic viability of fishing as a means of food production. World capture fisheries consumes about 50 billion litres of fuel annually (1.2% of the global fuel consumption) releasing an estimated 134 million tonnes of CO_2 into the atmosphere at an average rate of 1.7 tonnes of CO_2 per tonne of live-weight landed product (Tyedmers *et. al.*, 2005). Annual fuel consumption by the mechanized and motorized fishing fleet of India has been estimated at 1220 million litres which formed about 1% of the total fossil fuel consumption in India in 2000 (122 billion litres) releasing an estimated 3.17 million tonnes of CO_2 into the atmosphere at an average rate of 1.13 tonnes of CO_2 per tonne of live-weight of marine fish landed (Boopendranath, 2009).

Studies on GHG emmission from fishing vessel conducted at ICAR-CIFT has shown that the fuel consumption is the major factor contributing to GWP in both single day and multi-day trawler operations and hence offers scope for impact reduction through operational fuel savings. The GWP was incrementally higher for multi-day trawler operation corresponding to increase in size of trawlers. Global warming potential ranged from 2165 to 4328 kg CO_2 Eq. in wooden trawlers and from 2824 to 6648 kg CO_2 Eq. in steel trawlers depending on the size. The GWP was higher in very large trawlers due to inorganic emission to air especially carbon dioxide. The GWP had a negative value for renewable resources i.e., wood for construction, wooden otter board, marine plywood and cotton. Among the materials used for construction of a 40 m trawl net GWP was maximum for iron sinker (64.6%) followed by high density polyethylene (HDPE), webbing (17.0%), polypropylene (PP) rope (10.3%), HDPE float (5.0%) and lead sinker (3.1%).

Various approaches to energy conservation in fish harvesting such as: (i). Fishing gear and methods, (ii). Vessel technology, (iii). Engines, (iv). Reduction gear, propeller and nozzle, (v). Sail-assisted propulsion, (vi). Adoption of advanced technology, and (vii). Conservation, management and enhancement of resources, have been discussed by May *et. al.* (1981), Gulbrandson (1986), Wileman (1984), Aegisson and Endal (1993), Boopendranath (1996), Wilson (1999) and Boopendranath (2009). Other methods of energy conservation can be through use of Fish Aggregating Devices (FAD). The Institute has developed and standardized low-cost designs of floating FADs and benthic Artificial Reef (AF) modules, based on experiments off Andhra Pradesh coast, in order to make the fishing operations energy efficient and cost-effective, for the benefit of traditional fishermen operating fishing gears such as gillnets and lines.

Potential fishing zone (PFZ) advisory is important service, since fishermen can use less time and fuel in searching for areas of fish abunadance. PFZ advisory mainly rely on Chlorophyll and sea surface temperature retrieved from satellite. Fishing Technology Division, ICAR-CIFT has been working on this aspect for eight years. The main objectives are to provide *in situ* database on chlorophyll, coloured dissolved organic matter, detritus and nutrients along with other physical parameters of coastal waters of Kochi, validate the *in situ* measured Chlorophyll, coloured dissolved organic matter and detritus with satellite data and development of regional algorithms based on these *in situ* and satellite data to improve PFZ advisory.

Fishing vessel design: Fishing craft mechanization in India progressed through four stages, beginning with motorization of some of the existing designs of traditional crafts, followed by introduction of mechanized craft, introduction of more specialized crafts and broadening to a full-fledged fishing feet. ICAR-CIFT in collaboration with FAO naval architects introduced several standard designs of fishing crafts for different types of fishing operations. Twelve standard designs of wooden fishing boats in the size range of 7.67 to 15.24 m were developed and introduced by ICAR-CIFT, which gave a major filip to the mechanization programme of Indian fisheries. It has been estimated that over 80% of the mechanized wooden fishing crafts in the Indian fishing fleet conformed to the popular ICAR-CIFT designs or its later adaptations. Designs of boats for fishing in rivers and reservoirs, pole and line fishing vessel, trawler-cum-carrier vessel, steel trawler-cum purse seiner, gillnetter etc. were also developed by ICAR-

CIFT. Design of a steel fishing trawler (15.5 m) with energy saving features has also been introduced by the Institute.

Solar powered FRP boat for inland waters: The Institute has recently developed a solar powered FRP boat which can be operated in reservoirs, small rivers, and aquaculture ponds and can also be used for recreational fishing activities. The boat is capable of running for 2.5 to 3.0 hours after full charge and attains a speed of nearly 4.0 knots in calm waters. Considering the 240 days of fishing in a year, the fuel saved compared to an equivalent diesel powered boat is about ₹ 48,000. The boat has wider space, a canopy for protection from rain and sun, low rolling characteristics during ûshing, and also has provision of navigational lights to facilitate fishing in night.

Fuel effcient multi-purpose fishing vessel: ICAR-CIFT has been instrumental in introducing designs of commercial, research and multi-purpose vessels as per requirements of Governments and other organizations. Latest in these initiatives has been the introduction of fuel efficient multi-purpose fishing vessel FV Sagar Harita. The vessel built under the project "Green Fishing Systems for the Tropical Seas" (GFSTS) funded by National Agricultural Science Fund (ICAR-NASF) was officially

FV Sagar Harita of ICAR-CIFT

launched on 18 April, 2016. The hull of this vessel (19.75 m combination fishing vessel which can carry out trawling, gillnetting and longlining operations) is made of marine grade steel and the cabin and wheelhouse is made of FRP to reduce weight and to improve the carrying capacity and speed. The main engine power is 400 hp which is about 20% lower than vessels of comparable size.

The fishing gear handling equipment such as split trawl winch, long line setter and hauler, and gillnet hauler designed at ICAR-CIFT with hydraulic power were installed onboard. RSW tanks (0 °C to -1 °C) of 2 tonne capacity have been provided for fish preservation onboard. A 600 watt solar power panel has been installed for emergency lighting and navigational aids to promote the utilization of renewable energy resource and conserve the diesel consumption. Acoustic fish detection and trawl monitoring system with underwater sensors have also been installed onboard.

Conclusion In the context of dwindling catches from the wild the world over, there is a imminent need for all countries to implement the FAO-CCRF in totality for the sustenance of global fisheries. In India, technology that ensure responsible fishing have already been introduced into the sector through the past few decades. The ensuring of the complaints of fisheries management regulations through vigilant monitoring, control and surveillance would bring about a responsible fisheries regime in the country.

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