Chapter 2

Contribution of CIFT to Indian Fisheries

T. K. Srinivasa Gopal
Central Institute of fisheries Technology
Matsyapuri P. O., Cochin - 682 029
E-mail: tksgopal@gmail.com

1.0 Introduction

Fisheries is a major source of food and provides employment and economic benefits to large sections of the society in India. Fish is also very significant nutritionally, being an important source of quality proteins and fats as well as vitamins and minerals, though consumption still tends to be low at the national level.

India is the third largest producer of fish in the world and the second largest producer from aquaculture. The contribution of fisheries to the GDP during 2009-10 was 0.8 percent. The fishery has emerged as a sunrise sector which provides food, employment and economic benefits to large sections of the society. It is a source of livelihood for about 15 million people engaged fully, partially or in subsidiary activities pertaining to the sector. Besides, an equal number are engaged in ancillary activities in fisheries and aquaculture. Total fish production in 2009-10 stood at 7.85 million t comprising of 4.87 million t from Inland and 2.98 million t from marine sector (Fig. 1). The gross revenue from the catches at the point of first sales (landing centre) was estimated at Rs. 1,97,530 million, and at the point of last sales (retail market) as Rs. 2,85,110 million.

About 1,94,490 fishing crafts of various sizes and classes are under operation in marine fisheries, consisting of 72,559 mechanised boats, 71,313 motorised crafts and 50,618 non-mechanised crafts . Problems of juvenile finfish mortality and bycatch and discards in-

creased with the intensification of shrimp trawling. The need for sustainability and conservation of resources has taken centre stage in the shelf fisheries. In the inland sector, the productivity of riverine systems remain low and there is general agreement among fishery experts that the overall production from Indian reservoirs could be substantially raised, with adequate management measures such as optimum fishing effort, responsible fishing, stocking support and mesh size regulation. Fishing implements employed for inland fisheries of India are traditional and are mostly of non-selective type, and also include prohibited practices like fishing with poison and explosives. Fishing crafts in inland sector are largely traditional with fibreglass canoes catching up in certain areas.

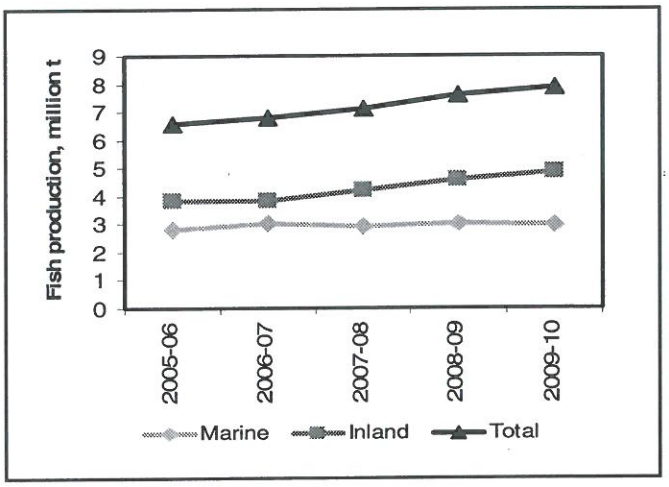

Fig.1. Trend in fish production in India (Source DAHDF, 2009)

The export of fish and fish products have shown a steady growth from a humble level of seafood worth 25 million in 1950-51 to 813091 t valued at Rs.129014.7 million (USD 2856.92 million) during 2010-11, exported to nearly 100 countries. The trend in quantity and value of seafood exports from India is shoen in Fig. 2. There has been significant growth in the seafood processing sector which at present consists of about 370 processing plants of which 246 are approved for exports to EU nations. The export basket which was earlier dominated by shrimp, has diversified to frozen finfish, squid, cuttlefish, fillets and other products. The seafood processed in India include frozen, breaded and battered shrimp, Individually Quick Frozen (IQF) products, pre-cooked products, Accelerated Freeze Dried (AFD) products, cooked and stuffed meat and surimi.

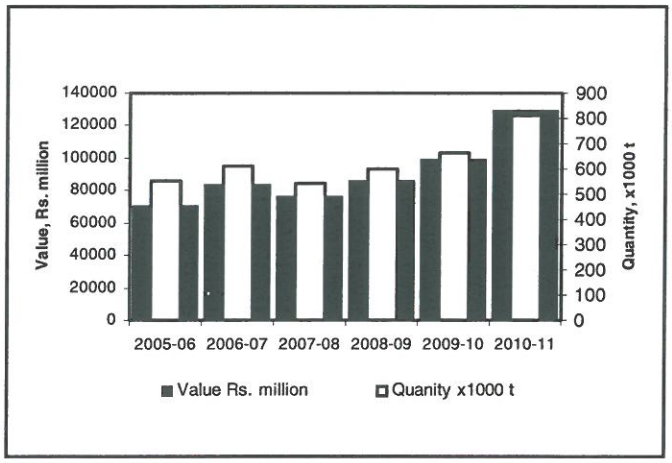

Fig.2 Trend in quantity and value of exports from India

The Central Institute of Fisheries Technology has played a pivotal role in the technological development and modernization of both the harvest and post-harvest sectors in fisheries from its nascent stage, by actively engaging in need based technology development as well as transfer. The Institute continues to be responsive to the dynamic changes that are taking place and emerging challenges in the fisheries sector.

2.0 Central Institute of Fisheries Technology

The Central Institute of Fisheries Technology (CIFT) is the only national Institute working on all aspects related to harvest and post harvest technologies in fish. The CIFT was set up as Central Fisheries Technological Research Station on the recommendations of a high power committee constituted by the Ministry of Food and Agriculture, Government of India. It started functioning at Cochin on 29th April 1957, under the Department of Agriculture of the then Ministry of Food and Agriculture. The initial complement of craft and gear researchers was expanded to include the fish processing in 1958 and extension in 1961. The Institute was given its present name in 1962. The administrative control of the Institute was brought under the Indian Council of Agricultural Research from 1st October, 1967. The Headquarters of the Institute is at Cochin with Research Centres at Veraval (Gujarat), Visakhapatnam (Andhra Pradesh) and Mumbai (Maharashtra). Research work of the Institute is orchestrated through seven Divsions viz., (i) Fishing Technology Division, (ii) Fish Processing Division, (iii) Quality Assurance & Management Division, (iv) Biochemistry and Nutrition Division, (v) Microbiology, Fermentation and Biotechnology Division, (vi) Engineering Division and (vii) Extension, Information and Statistics Division.

The Vision of the Institute is to facilitate sustainable harvesting and total utilization of fishery resources through innovations in harvest and post harvest technologies and its Mission is to ensure responsible harvesting of fishery resources through eco-friendly, energy efficient and economical means; ensure total utilization of the harvested fish through appropriate processing, value addition, packaging and waste utilization; ensure food safety and

nutritional security to the consumer and minimise carbon and water footprint per unit volume; and to ensure equitable benefits to the stakeholders, across the value chain. The mandate of the Institute consists of the following:

- To conduct basic, strategic and applied research in fishing and fish processing.
- To develop designs for fuel efficient fishing vessels and fishing gear for responsible fishing.
- To develop technologies for commercial isolation of bioactive compounds and industri ally important products from fish and fishery wastes.
- To design innovative implements and machineries for fishing and fish processing and pilot plants for facilitating commercialization of technologies developed.
- To do advanced research in food safety in fish and fishery products.
- To provide training and consultancy services in fishing and fish processing.

The Institute has well equipped laboratories with modern, sophisticated, state-of-the-art equipment for both fundamental and applied research, an excellent library, a workshop and an animal house, an Agricultural Knowledge Management Centre (AKMC) and Agricultural Technology Information Centre (ATIC). The laboratories of the Institute also cater to the needs of the industry by testing processed fishery products, ice, water, and other materials like fishing gear and craft materials, packaging materials, marine paints, fishing craft and engines. A Business Planning & Development (BPD) Unit is also functional in the Institute to ensure commercialization of technologies on a public-private partnership mode. The Institute also facilitates IP management of ICAR Institutes in the Southern region through the Zonal Technology Management Centre (ZTMC).

The impact of CIFT on the development of fishing, seafood processing, seafood safety and quality control in India is well recognised. The Institute played an important role in facilitating mechanisation and modernisation of fishing fleet and introduction of durable synthetic fishing gear materials and improved gear designs and practices in Indian fisheries. The Institute's interventions have resulted in the adoption of improved methods of trawling, purse seining, gill netting, lining and trap operations and efficient vessel designs; improved methods of fish curing, fish processing, fish based value added products, fish waste utilisation and packaging; sanitary and hygienic standards based on microbiological and biochemical quality parameters and HACCP. CIFT has gained recognition for the production of bioactive and pharmaceutical compounds from aquatic resources. The Institute has developed several instruments and machineries for meeting specific needs of fishing and fish processing sectors. Recent focus has been on development of conservation technologies such as energy efficient fishing vessels, bycatch reduction technologies, juvenile excluder devices, turtle excluder devices, energy efficient fishing gears, renewable energy based fish processing systems such as solar fish dryers and utilisation of fishery byproducts and fishery wastes, intelligent and active pacakging systems and development of innovative quality systems.

Research Centres in different parts of the country caters to redressel of location specific technological problems faced by the industries. CIFT gained the status as referral laboratory in fishery technology. It is also accredited by National Accreditation Board for Laboratories (NABL). The Institute conducts regular need based training programmes in responsible fishing techniques, fish processing, value added fish based products, quality assurance systems, fisheries microbiobiology and biochemistry and stakeholder empowerment programmes particularly targeting women and weaker sections with specific programmes for backward areas of Islands and North East region of the country. CIFT has been awarded as the Best Institute in the ICAR system twice, in the years of 2000 and 2006.

3.0 Highlights of Technological Contributions of CIFT in Harvest Sector

CIFT has developed and popularized standard designs of fishing vessels in the size range 7.67-15.24 m, suitable for various types of fishing under the Indian conditions and appropriate gear systems for trawling, seining, gillnetting, lining and trapping. Modernisation of fishing vessels and development of fuel efficient designs have been undertaken and newer craft materials have been introduced to reduce the cost of operation and increase the income of fishermen. Important contributions of the Institute in recent years in harvest sector include the following:

3.1 Fuel efficient fishing vessels

In view of high expenditure incurred in mechanised fishing operations, CIFT has taken initiative to develop fuel efficient fishing vessels. A 15.5 m multi-purpose deep sea fishing vessel Sagarkripa 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 (Fig. 3). The commercial trials by the fishing boat operators have realized about 17% savings in the fuel cost.

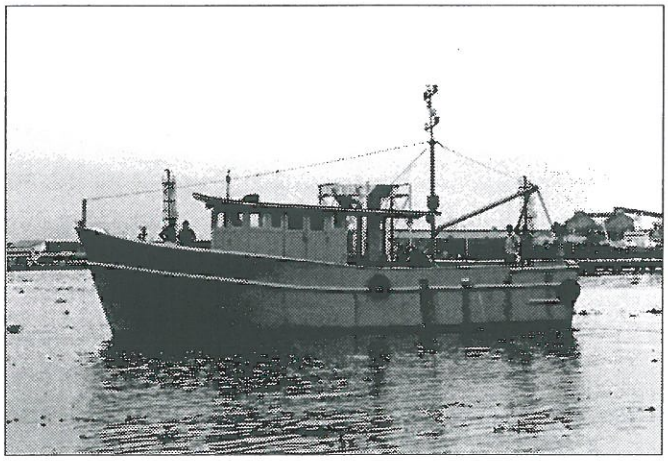

Fig. 3. MFV Sagar Kripa - 15.5 m LOA, 120 hp fuel-efficient steel combination vessel

3.2 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 under utilized 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.

3.3 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.

3.3.1 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.

3.3.2 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. 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. This technology is expected to be adopted when the concept of semipelagic trawling become popular among trawler fishermen.

3.3.3 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.

3.4 Eco friendly trawls for semi-pelagic resources

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. CIFT Semi-pelagic Trawl System (CIFT SPTS) 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 (Fig. 4). It facilitates harvesting of fast swimming demersal and semi-pelagic finfishes and cephalopods, which are mostly beyond the reach of conventional bottom trawls, currently used in commercial trawl fisheries in India.

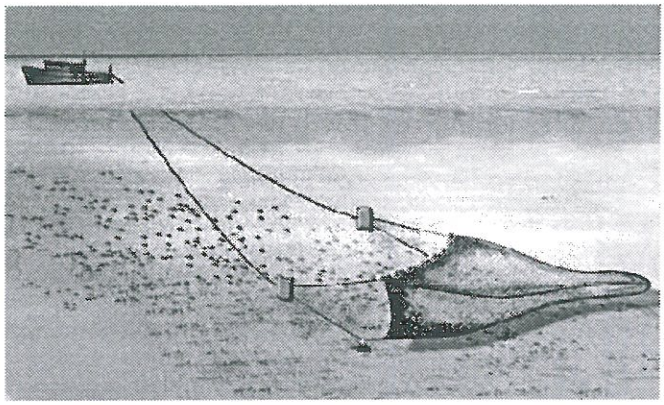

Fig. 4. CIFT-SPTS: Eco-friendly trawl system

3.5 Bycatch Reduction and Turtle Excluder Devices

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. Sea turtles are endangered species. Various protection measures have been adopted the world over, including India, for its protection. CIFT has 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 CIFT, great care has been taken to ensure 100% escapement of the turtles while escapement of fish and shrimp at the minimum possible level.

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

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.

Fig. 5. CIFT designed lobster trap

The rich tuna resources of the Lakshadweep waters are under-exploited as the fishing operations are still limited to traditional pole and line method. CIFT has introduced large mesh gill nets 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.

3.7 Large mesh purse seine and power block for purse seine operations

Introduction of large mesh purse seines facilitated by 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 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. The use of hydraulic power block in purse seine operations was demonstrated for the first time in small-scale mechanised purse seine sector (Fig. 6).

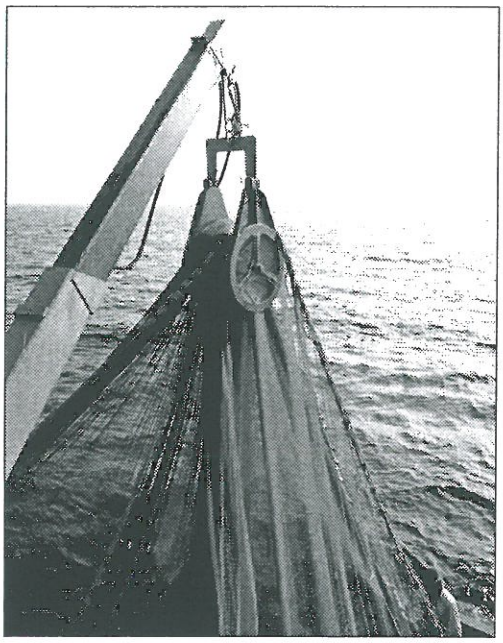

Fig. 6. Power bloc for purse seine operation

3.8 Use of advanced fish finding and navigation techniques

Recent advances in technology have provided fishermen with equipment to reach the po-

tential 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.

4.0 Highlights of Technological Contributions of CIFT in Post-harvest Sector

The fish being a perishable commodity are vulnerable to losses at different points in the production to consumption chain. Hence, it is necessary to preserve the harvested catch judiciously and minimise waste, during post-harvest operations. Present market trends reflect a rapidly growing demand for ready-to-cook and ready to serve convenience products. Value addition by adopting modern technologies can increase the unit value of fish products considerably. The seafood processing sector has been professionally supported by evolving suitable technologies for efficient utilisation of the landings, assurance of quality and minimisation of waste. Technologies for fishery byproducts and waste utilization have been developed to minimize environmental pollution resulting from processing of fish and to convert waste into wealth. Suitable technologies on production of value added products and byproducts, waste utilization and effluent treatment have been developed and transferred to the industry. Packaging technologies for ready-to-eat products has had a positive impact on the market with entrepreneurs taking up the technology on consultancy basis. Solar hybrid dryers have been developed for conservation of energy in fish processing. The recent developments have improved techniques in handling, product development, packaging, preservation and storage. The seafood sector can assure food safety by adopting modern technology and quality management systems such as HACCP and ISO 9000 series. Some of technological developments in post-harvest sector in India facilitated by CIFT are discussed below:

4.1 Chilled storage in modified atmosphere

Chilled storage in different containers has been practised in the case of fish and fish products for a long time. Modified atmosphere packaging (MAP) or controlled atmosphere storage by the application of CO_2 at concentrations ranging from 50 to100% to fresh fish in chilled condition is a recent introduction which substantially increases the shelf life (Fig. 7). The modified atmosphere retards the growth of microorganisms and reduces the rancidity in fatty fishes. Hence MAP chilled fish has an extended shelf life of 10 days or more depending on the species. Central Institute of Fisheries Technology has standardized the optimum concentration of various gases in MAP for different products to get maximum shelf life and retention of quality.

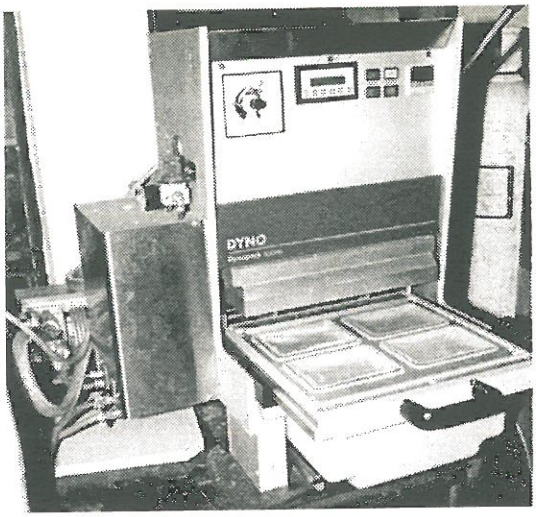

Fig. 7. Modified atmosphere packaging (MAP) system

4.2 Active packaging

Active packaging changes the condition of the package to extend the shelf life or to improve the safety while maintaining quality of the foods. The condition of food is regulated in numerous manners through the application of appropriate active packaging systems. There are two types of active packaging systems viz., scavenging systems (absorbers) and releasing systems (emitters). Scavenging systems remove undesirable compounds such as oxygen, excessive water, ethylene, carbon dioxide, taints and other specific food compounds. Releasing systems actively add compounds to the packaged food such as carbon dioxide, water, antioxidants or preservatives. Most important active packaging concepts include O_2 and ethylene scavenging, CO_2 scavengers and emitters, moisture regulators, anti-microbial packaging, antioxidant release, release or adsorption of flavours and odours. Studies carried out at CIFT has indicated significant improvement in the shelf life of striped catfish (*Pangasianodon hypophthalmus*) steaks, narrow-barred Spanish mackerel (*Scomberomorus commerson*) steaks and dressed Indian oil sardine (*Sardinella longiceps*) in active packaging systems compared to the corresponding air packed samples.

4.3 Freezing

Freezing is the most satisfactory method for long-term preservation of fish products. The advancements in the freezing of fish products are mainly in the technological aspects of freezing and also in the introduction of newer frozen products. The freezing time in plate freezers have been reduced to more than half by the introduction of double contact plate freezers. Semi-automatic and automatic horizontal plate freezers and rotary drum types of freezers have been introduced. Spiral freezers and fluidized bed freezers replaced the conventional tunnel freezers for Individually Quick Frozen Products (IQF) products. These freezing systems considerably reduce the space occupied by the freezers and also freezing

time. Very efficient and effective cryogenic freezing systems are also developed. Another innovation in freezing is the pressure assisted freezing. In this system freezing occurs due to the pressure induced melting point depression, which enables water to remain in liquid phase at higher pressures. The melting point of ice is lowered to -22°C at a pressure of 207.5 MPa. Release of pressure enables rapid and uniform nucleation of water in a food product leading to freezing. This type of freezing produces smaller ice crystals rather than stress inducing ice front moving through the sample.

IQF products fetch better price than conventional block frozen products. However, for the production of IQF products raw-materials of very high quality need to be used, as also the processing has to be carried out under strict hygienic conditions. The products have to be packed in attractive moisture-proof containers and stored at -30°C or below without fluctuation in storage temperature. Thermoform moulded trays have become accepted containers for IQF products. Some of the IQF products in demand are prawn in different forms such as whole, peeled and de-veined, cooked, headless shell-on, butterfly fan tail and round tail-on, whole cooked lobster, lobster tails, lobster meat, cuttlefish fillets, squid tubes, squid rings, boiled clam meat and skinless and boneless fillets of white lean fish. Some of the speciality products from shrimp are stretched shrimp or nobashi, barbeque, skewered shrimp, head on centre peeled and cooked shrimp.

4.4 Drying

The water activity of fish products is reduced by drying or salting and drying. The conventional method of drying is by exposing fish with or without salting to sun by spreading over exposed surfaces which is a cause for contamination. Modifications have been made in sun drying in order to reduce contamination. Solar tent drying, drying on platforms or rack are the results of such attempts. These modified methods improve quality substantially. CIFT has developed solar fish dryers having capacity with alternate back up systems ranging from 10 to 1000 kg (Fig. 8). When solar radiation is not sufficient as during cloudy or rainy days, LPG, electricity or biomass backup will be automatically activated to supplement the heat requirement.

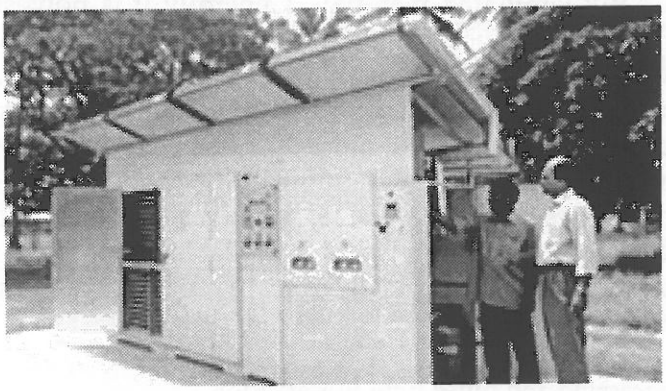

Fig. 8. CIFT Solar dryer

4.5 Freeze drying

Freeze dried fish products are prepared by freezing the product and subliming the ice under low pressure. The structural changes in this type of drying are minimum and flavour is retained to the maximum. Some of the important types are tray freeze dryer, continuous belt freeze dryer, continuous circular plate freeze dryer and fluidized bed freeze dryers.

4.6 Thermal processing

Thermal processing (canning) involves several heating processes such as cooking, blanching, pasteurization and sterilization. The objective of thermal processing is to inactivate or destroy the microorganisms and the enzymes. At the same time, maximum retention of nutrients is also very important. In preliminary cooking and also in sterilization it is observed that high temperature and short time process favour nutrient retention without sacrificing the rate of destruction of microbial spores. The major problem is the retention of some of the heat resistant enzymes by this method. The still retort is the oldest type of equipment used in sterilization or thermal processing. In conventional system the method consists of loading crates of containers into the retort, closing it and heating with steam. Improvement in the systems have centred on the mechanics of handling the containers. The recent development is the introduction of a "crate less" container handling system. Continuous retorts have distinct advantages over batch type retorts like greater production rate, lower labour cost and higher rate of heat transfer. Different types of materials are used now for making containers for canning. The main materials used are glass, tin plate, steel, aluminum and metal foils laminated with plastics. Cans made into different styles from metals like beaded cans, cemented side seam cans, two piece cans, drawn and wall ironed cans, drawn and redrawn cans and necked in cans are available. Easy open end cans and retortable pouches have been introduced and have become very popular.

4.7 Ready-to-serve fish products in retortable pouch

Ready-to-serve fish products viz., curry products, in retortable pouches are a recent innovation in ready to serve fish products for local market. The most common retortable pouch consists of a 3 ply laminated material. Generally it is polyester/aluminium/cast polypropylene. Some of the products standardized by CIFT are mackerel curry, rohu curry, sardine curry tuna curry, pomfret curry, prawn curry, seer fish moilee, pearl spot moilee, fried mussel, fish sausage, prawn kurma, prawn Manchurian, fried mussel and mussel masala. These products have a shelf life of more than one year at room temperature. Retort pouches which are made up polyester/aluminium/cast polypropylene, the product cannot be seen. During recent years pouches made up of polyester coated with aluminium oxide or silicon dioxide/Nylon/cast polypropylene are available. As there is increasing demand in National and International market for ready to serve products the retort pouch technology will have a good future.

4.8 High pressure processing and pulse light preservation

High Pressure Processing (HPP) is a method of food processing where food is subjected to

elevated pressures up to 87,000 pounds per square inch, with or without the addition of heat, to achieve microbial inactivation or to alter the food attributes in order to achieve consumer-desired qualities. Pressure inactivates most vegetative bacteria at pressures above 60,000 pounds per square inch. HPP retains food quality, maintains natural freshness, and extends microbiological shelf life. Pulse light technology is an emerging non thermal processing method and involves exposure of foods to short duration pulses of intense broad spectrum light. The effectiveness of light pulse treatment depends on several factors such as intensity, treatment time, food temperature and type of microorganisms. At present, industrial applications of light pulse technology for seafood processing has been rather slow, despite its potential in this area. Application of HPP and pulse light technology for seafood processing is given active attention at CIFT, in recent years.

4.9 Value addition

Processing adds value to the harvested resource. It has been one of the strengths of the Institute and various new products have been standardized that can be taken up by entrepreneurs at various scales of production. Emerging species in aquaculture and hitherto untapped species from wild caught production will be given more importance for product development and standardization. An important aspect of value addition is ready to eat, ready to cook and ready to fry products.

4.9.1 Extruded products

Extrusion is a process which combines shear, pressure and temperature leading to molecular transformations in the constituents and involves denaturation of the proteins, fragmentation of the starch molecules and changes in the non-covalent bonds between proteins, lipids and carbohydrate (Fig. 9). Fish based extruded products have very good market potential. The advantages of extrusion process are (i) high thermodynamic efficiency of the process, (ii) destruction of bacteria and anti-nutritional factors by high temperature short time treatment, (iii) minimisation of wastage due to one step cooking process and (iv) destruction of fat hydrolyzing enzymes during extrusion cooking. CIFT has standardized the production of extruded products by incorporating "Fish Kure" is one such product coated with chaat masala.

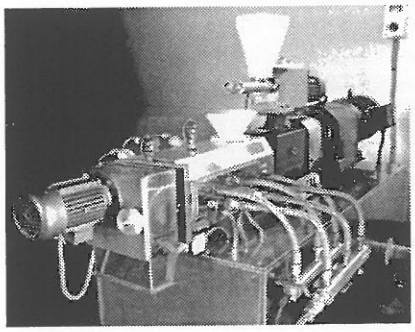

Fig. 9. Twin screw extruder

Fig. 10 Fish Kure

4.9.2 Smoked products

Smoking of fish products is a very old method of preservation. In addition to preservation, smoke imparts a particular flavour to the product. Smoking may lead to deposition of polyaromatic hydrocarbons (PAH) such as 3,4 benzopyrene which are carcinogenic. Modern smoke kilns have the facilities to control the level of PAH to acceptable levels. CIFT is evaluating application of liquid smoke for preparation traditional smoked fish products which has several advantages such as ease of application, uniformity of the product, good reproducibility of desired characteristics and exclusion of harzardous polycyclic aromatic hydrocarbons.

4.9.3 Battered and breaded products

Battered and breaded products offer a convenient food valued widely by the consumer (Fig. 11). Battering and breading enhance food product's appearance and organoleptic characteristics in addition to improving its nutritional value. Coating acts as a moisture barrier, minimizing moisture losses during frozen storage and microwave re-heating. The most important function of coating is value addition by increasing the bulk of the substrate thereby reducing the cost element of the finished product. Battered and breaded products packed in consumer packs after freezing are sold through super markets as ready to fry items. The production of battered and breaded fish products involves several stages. The method varies with the type of products and pickup desired. In most cases it involves portioning or forming, pre-dusting, battering, breading, pre-frying, freezing, packaging and cold storage. Some of the important coated fish and fishery products are fish fingers, fish portions, various shrimp based products, squid products, clam and other related products, fish fillets, mince based products such as fish cutlets, burgers, fish balls, imitation products and crab claw balls.

Fig. 11. Coated product from lanternfish mince

4.9.4 Fish mince and surimi based products

Minced fish is the meat separated from lean whole fleshed fish in comminuted form free of

bones and skin etc. Flesh can be separated from filleting waste also. Minced fish can be used as a base material for the preparation of a number of products of good demand. The properties of minced fish to a large extent are determined by the nature and quality of raw material. Meat-bone separators of different types are available for the preparation of minced fish. Minced fish from marine as well as freshwater fish is used for the preparation of a number of products like fish sausage, cakes, cutlets, burgers, balls, pastes, surimi and texturised products etc. The processes for the production of most of these products are available and some of them are very much suitable for starting small scale industries.

Surimi is the myofibrillar protein concentrate produced by repeated washing of fish mince in order to remove water soluble nitrogenous matter and flavour compounds. Washing enhances the gel forming capacity of the structural proteins. Surimi is used as a raw material for the preparation of seafood analogues, but in Japan, surimi is mainly used to prepare the traditional products such as kamaboko (boiled fish paste), chikuwa (tube shaped fish paste), satsumaage (fried fish paste product), hampen (floating type boiled fish paste) (Fig. 12). Fibreized products are the greatest in demand among the surimi based imitation shellfish products. The ingredients used in the formulation of fibreized products includes, besides surimi, salt, starch, egg white, shellfish flavour, flavour enhancers and water. All the ingredients are thoroughly mixed and are ground to a paste. The paste is extruded in sheet on the conveyor belt and is heat treated using gas and steam for partial setting. A strip cutter subdivides the cooled sheet into strings and is passed through a rope corner. The rope is coloured and shaped. The final product is formed by steam cooking the coloured and shaped material.

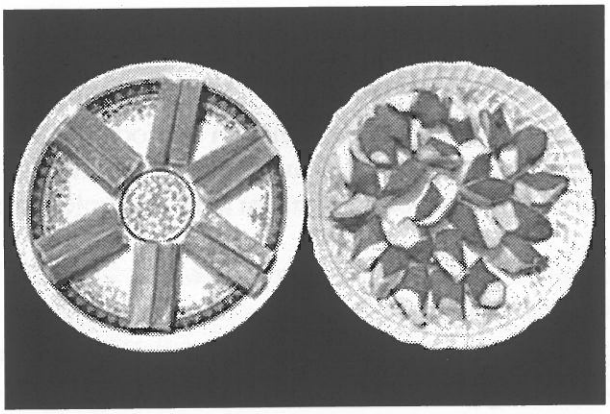

Fig. 12. Surimi based analogue products

4.9.5 Oyster Peptide Extract (OPex) from edible oyster

Central Institute of Fisheries Technology has developed an edible oyster (*Crassostrea madrasensis*) peptide-based nutraceutical, OPex. OPex is a 100% natural blend of oyster peptides & oyster protein concentrate that has been scientifically proven in experiments conducted in the state-of-the-art-laboratories of Biochemistry & Nutrition Division, to possess

several bioactivities. Bio-activities of significant mention are anti-inflammatory, anti-oxidant and anti-bacterial properties. Oysters are a good source of high quality easily digestible protein and essential amino acids of high amino acid score and hence quite beneficial for human health.

4.9.6 Utilization of fish processing wastes and low value bycatch

It has been demonstrated that the low value bycatch and waste generated from fish processing can be used to develop novel products of high value in domestic and international markets, such as chitosan, glucosamine hydrochloride, gelatin, polyunsaturated fatty acid (PUFA) (Fig. 13), squalene, fish meal and oil. Attempts to extract new and useful compounds from waste will continue to be an area for future research.

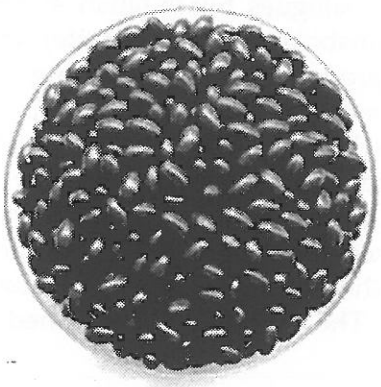

Fig. 13. Encapsulated PUFA

4.10 Rapid method for detection of salmonella in seafood

A method for rapid enumeration of Salmonella in seafood by real-time PCR assay was developed with a level of detection of 2cfu/g and detection time of 2-3 h. The realtime assay was far superior as compared to Salmonella Chrom agar for rapid enumeration of Salmonella in seafood.

4.11 Energy-efficient Effluent Treatment System

An energy-efficient Effluent Treatment Plant (ETP) has been developed for treatment of effluents of seafood processing factories. CIFT designed ETPs have been installed in several seafood processing establishments. One such system installed at Aroor (Ernakulam, Kerala) has been awarded Second Position by Kerala State Pollution Control Board (KSPCB) for the year 2011, in an evaluation in connection with the World Environment Day celebrations. The ETP is very energy-efficient, ecofriendly and the treated discharge conforms to standards set by the Pollution Control Boards.

5.0 Transfer of Technology

The Institute also conducts research in various areas of social sciences having management

and policy level implications in fisheries like idle capacity in fish processing plants in India, price analysis of Indian seafood in the export market economics of different fishing systems and marketing studies. Feedback for technology development and transfer is also provided by assessing socio-economic profile of fisherfolk in different parts of the country and development of socio-economic status scale, extent of participation of women in fisheries related activities, the types and activities of co-operatives and other organizations in fisheries and the role played by them in small scale fisheries, adoption behavior including extent of adoption, communication, decision making, response to technological gaps of fishermen in different sectors. Evaluation of the training and extension programmes taken up by the Institute in terms of gain in knowledge, awareness, practices and constraints is also taken up. GIS applications in development of maps of infrastructural facilities and markets in the sector have also been attempted.

6.0 Conclusion

Rapid developments have taken place in harvest and post-harvest technologies in fisheries sector, in recent years. While the fisheries sector is facing challenges in terms of excess capacity, resource depletion and changes in the fisheries environment in the coastal waters, under-utilised and unutilised resources in the deeper waters hold potential along with rapid expansion envisaged in the aquaculture sector and culture based capture fisheries from reservoirs. There is need for application of resource conservation technologies in the shelf waters under an appropriate management plan and diversification of fishing to under-utilised 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 and post-harvest operations and value addition are areas which need focussed attention, in addition to responses to emerging issues in seafood safety and quality standards for the domestic and export markets.

Central Institute of Fisheries Technology has contributed to the modernisation of Indian fisheries in a very significant way. The technology transfer programmes of CIFT in the fisheries sector have greatly contributed to the development of infrastructure and human resource as well as improvement in quality of products and have helped the country achieve a covetable position in the global fisheries scenario. CIFT has worked for both the high technology needs of the industry and the needs of the traditional fishing sector to improve the socio-economic upliftment of the weaker sections. The Institute is being looked upon for guidance and for technology innovation by both governmental agencies as well as private entrepreneurs in seafood sector.