E- manual

on

# Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries


भाकृ अनुप
ICAR

**ICAR - Central Institute of Fisheries Technology**
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## Foreword

ICAR-Central Institute of Fisheries Technology was established as Central Fisheries Technological Research Station (CFTRS) on $29^{th}$ April 1957. Building a scientific institution requires decades of dedication of not by one individual, but of a strong team with indomitable altruistic spirit. This team spirit and scientific temperament has helped CIFT to contribute significantly to all domains of harvest and post-harvest technology development I in fisheries and its dissemination to relevant stakeholders. Knowledge gaining requires extremes of endeavours, but more important is spreading the same to different levels for attaining larger economic and social goals. In this regard, the present international training programme under Indian Technical and Economic Cooperation (ITEC) Programme on **'Extension Management Techniques for Up-scaling Technology Dissemination in Fisheries'** held from 9-22November,2018is an illustration of the indomitable team spirit and commitment to impart knowledge for the welfare of human kind. This training is organised as a bilateral programme of assistance of Govt of India, under Ministry of External Affairs. I am sure that the knowledge and experience gained during the training will be very much useful for the participants in their respective work environment in their countries The manual contain more than 28 chapters coveringinnovative Extension Management Techniques and also important aspects of harvest and post-harvest fisheries by experts in the field with decades of experience. On behalf of CIFT, I congratulate our international executive guests from Algeria, Bangladesh, Guatemala, Malawi, Mauritius, Oman, Sri Lanka, Sudan, Syria, Tanzania, Tunisia, Uganda and Zimbabwefor their active participation. I wish they become brand ambassadors in taking forward the knowledge gained to the respective countries to achieve food and nutritional security and bring about socioeconomic development of the people engaged in the fisheries sector.

Dr. C.N. Ravishankar
Director
ICAR-CIFT

# Content

# Chapter 1

## Indian fisheries: Harvest and Post-Harvest Scenario

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Fish as a cheap source of protein, bioavailable minerals, vitamins and essential fatty acids, ensures global nutritional security. India witnessed around 14-fold increment in fish production from 0.7 million tonnes in 1950's to 10.43 million tonnes in 2014-15. With a contribution of 5.05% to world's capture production and 6.6% of total aquaculture fish production, India emerged as one among the most progressive fish producing countries in the world. Fisheries as a major agricultural sector, constitutes 0.92% of total GDP and 5.58% of total agricultural GDP of India. With the global fish export value of 148,147 million USD, India ranked seventh position among the top fish exporters of the world. The sector is crucial in securing food supply, job opportunities, nutritional needs and earning foreign exchange for the country, cataloguing it as a sunrise sector of Indian economy.

**Technological developments in harvest sector**

Introduction of new materials for fishing gears, mechanization of fishing crafts and modern electronic technologies for navigation and fish location, paved way for the significant increase in fish production in India over the years. ICAR-CIFT has been involved in the design and optimization of a range of crafts and gears since its inception, which gave a major fillip to the harvest sector of Indian fisheries. Considering the plateauing /decline in catches perceptible since last two decades, ICAR-CIFT has shifted its focus from increasing production to responsible harvest of resources. As a result a large number of technologies for sustainable harvest and green technologies with reduced emissions were developed.

**Environmental protection and eco-friendly technologies for harvest sector**

The Institute has successfully constructed few rubber wood canoes treated with a dual preservatives and combination treatment technology developed at the Institute for marine and backwater fishing. The cost of the canoe is 35-40% less than a canoe of same size built of 'Anjili' (*Artocarpus hirsuta*), the usually used wood. This saves the depleting forest wealth, helps the rubber farmer to get a better prize for the under-utilized wood and gives a durable, maintenance-free boat at affordable cost to the poor (Fig.1).

Six new designs of eco-friendly and resource specific demersal trawls were developed. Trials carried out have shown that with proper rigging, none of the designs dragged bottom debris and benthos, preserving the bottom ecology of the trawling grounds.

V-form otter boards designed and popularized by the Institute have also helped in eco-friendly trawling which has become popular along Gujarat, Andhra Pradesh and Kerala coasts.

## Harvest technologies for responsible fishing

Square mesh codends and V form otter boards were popularized as eco-friendly and conservational fishing methods. Square mesh cod ends were seen to function better than diamond mesh in conservation by ensuring escapement juveniles.

Use of optimum mesh size for target species and size class is imperative in order to prevent capture of non-target species, sub-adults and juveniles. With this in mind, a simple device for easy measurement of mesh size was developed. Selection of right size of mesh will help in popularizing responsible fishing.

Turtle Excluder device (TED) developed at the Institute was tested at Cochin, Visakhapatnam and Paradeep and found to be working satisfactorily. Turtle escape was 100% with minimum loss of valuable catch. The device is being popularized in maritime states where fishing induced turtle mortality is reported to be high.

The purse fishery of Kerala was facing hard times and as the number of vessels was reduced to 17 from 100 when ICAR-CIFT came up with suggestions for change in the mesh size. The purse seine nets and ring seines of Kerala are criticized for its very small mesh size (10-18 mm) destroying the fish wealth, as very small fish and juveniles cannot escape the net. The newly introduced purse-seine net has 45 mm mesh which has improved the catches. With increased mesh size, the target species were large sized mackerels, skipjack tunas, pomfrets, large sized carangid species etc. This net has found wide acceptance among fisherman. The new version of purse seine is a step towards conservation of fishery resources and at the same time assures good income to the fishermen, as the catches are of good marketable size.

CIFT SPTS-1 was developed as an alternative to shrimp trawling in the small-scale mechanized trawler sector, after extensive field –testing .It is capable of attaining catch rates beyond 200kg.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.

## Harvest technologies for the traditional sector

An improved design of FRP boat for backwater fishing was developed and canoes constructed for use in place of wooden canoes, which are very costly. Light weight, strength and durability are the main advantage of this material. They also have longer life when compared to traditional wooden canoes, which is a boon to the poor fisherman. The boat can be used for coastal fishing also.

Fiberglass reinforced plastic (FRP) sheathed, untreated rubber wood canoes were constructed and given for experimental fishing to artisanal fishermen. Both, the preservative treated rubber wood canoe and FRP sheathed untreated rubber wood canoe, were found to be in sound condition even after 26 and 16 month field operation respectively. Fishermen have shown interest in the new technologies.

High tenacity nylon monofilament of mesh size 30 mm bar were found to be superior to nets with other mesh sizes and was found best for fabrication of gillnets for obtaining good catches.

Design of twin hulled 3.6 m solar-powered boat for use in aquaculture farms, gillnetting, line fishing, transportation and aqua tourism (Fig.2). The boat with length of 3.6 m is twin hulled and is solely propelled by solar power. It can be put to use in aqua farms for aquacultural purposes and for gillnetting, line fishing, transportation and aqua tourism. Its main advantages are that it does not burn fuel, there is no atmospheric or sound pollution, has more deck space with clean FRP surface for fish handling and is suitable for shallow waters.

**Harvest technologies for the mechanized sector**

A prototype of a 5.22m $L_{OA}$ aluminum alloy boat was designed and constructed for fishing and related activates in reservoirs and rivers. This is the latest in a series of materials being evaluated by the Institute for construction of fishing vessels for the artisanal as well as mechanized sectors. Light weight, corrosion resistance, toughness and resilience make aluminum alloy a good material for construction of marine craft. This new material avoids expenditure on paints etc. and gives good re-sale value.

A sail system for use on-board medium class fishing vessels was developed for reducing fuel consumption during free running mode.

Experimental fishing carried out with nylon gillnets and hand lines at Agatti islands, Lakshadweep have revealed the scope for use of these gears on the island. The islanders are now taking to such fishing methods in addition to the traditional pole and line fishing for tuna.

Standardized the parameters to exploit semi-pelagic fishery resources.

Separator trawl studies confirmed the differential behavior and sorting of catch to the lower and upper cod ends. The Internationally recognized Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) was the resulting invention.

Design and construction of an energy efficient, green combination fishing vessel named, ‘Sagar Haritha’. The 19.75 m multi-purpose fishing vessel, FV Sagar Harita, built under the project “Green Fishing Systems for the Tropical Seas” funded by National Agricultural Science Fund is a fuel efficient combination fishing vessel combines deep sea fishing methods like long-lining, gill netting and trawling (Fig.3). This development has turned out to be a land mark in the deep sea fishing industry of the country as no standard design of combination fishing vessel incorporating fuel efficiency features, to reduce carbon foot print is available for mechanized fishing sector of Kerala. Modifications in the hull design and changes in the operation parameters of this fishing vessel significantly reduce fuel consumption and emission of green house gases. The hull of the vessel is made of marine grade steel and the cabin and wheel house is made of FRP to reduce weight and to improve the carrying capacity and speed. The main engine power is 400 hp which is 20% lower than comparable size vessel. The fishing gear handling equipment such as split trawl winch, long line hauler, setter and gillnet hauler designed at ICAR-CIFT with hydraulic power are installed onboard. A 600 watt solar power panel is designed and installed for emergency lighting and navigational aids to promote the utilization of renewable energy resource in the sector. Acoustic trawl telemetry system with under water sensors is also installed onboard.

**Harvest technologies for the inland fisheries sector**

- Monoline fishing (long lining) was introduced for the first time in the reservoirs (Hirakud reservoir).
- Trammel nets of 70mm bar mesh size were found superior to other mesh sizes tried in the reservoir, contributing to 76% of the total catches
- Potential fishing zones of Thangu reservoir on Hariharjore, a tributary of Mahanadi, were demarcated based on optimum water quality parameters and depth. Survey was undertaken of some of the rivers of North Kerala with particular reference to use of bamboo in fishing. Bamboo is currently used in fabrication of traps, barriers and as gear and aquaculture accessories.
- ICAR-CIFT has designed and fabricated new collapsible fish trap and crab trap for the helping the poor fishermen operating fish traps. Crab traps were operated in Cochin backwater with fish and chicken waste as bait. The design of the collapsible trap is simple and cost-effective and any fisherman can adopt the technology. Since it is made of synthetic netting, it is light in weight. A fisherman can transport and easily operate 10-15 traps using a canoe unlike the traditional traps.

**Technological developments in post harvest sector**

***Preservation and processing aids***

Chilling is the most common and traditional method of keeping fish in fresh condition. The simplest way for chilling is icing, by which fish can be kept for 12-15 days without spoilage. However, fatty fishes like oil sardine and mackerel show visible signs of spoilage even before 10 days of storage in ice. Freezing is the major processing technique applied for long term storage of fishes for human consumption. About 12% of the fish catch is frozen for further marketing or utilization against 26% in world scenario. Fisherfolk with no/little access to modern facilities rely on the traditional methods for the preservation of fish. This includes drying, salting, pickling and smoking. All these techniques are still in practice and are preferred over a wide range of population, even though chilling and freezing gets a preference. Drying and curing also remains as of considerable importance for the utilization of seasonal bulk landings. The conventional method of curing follows sun drying the whole/gutted fish with or without prior salting. Cured fish products have good economic potential and fetch attractive prices in global market.

ICAR-CIFT has introduced a hybrid solar dryer with an alternate electrical back up heating system. Effective harnessing of solar energy using specially designed solar air heating panels and proper circulation of this hot air across the SS trays loaded with fish with the help of blowers makes the drying process faster (Fig.4). The chance of contamination and spoilage due to sand, dust, flies, insects, birds, animals and rain is completely eliminated as drying takes place inside closed chamber. The spreading of fish in S.S. perforated trays and stacking of the trays inside the drying chamber helps in reducing the space requirement of the drying process. The alternate electrical back-up heating system under controlled temperature conditions enables drying to continue even under unfavourable weather conditions like rain, cloud, non-sunny days and even in night hours, so that the bacterial spoilage due to partial drying will not occur. The eco-friendly solar drying system reduces fuel consumption and ensures significant impact in energy conservation. In India, on an average, 5% of the total fish catch is converted to cured products against 12% of the cured product proportion in world fish production.

Smoking or smoke curing is an ancient method of preservation of fish. Smoking also imparts a unique taste and flavour to the fish. It is an age old practice of preserving certain varieties of fish like tuna and little tunnies. The practice of smoke curing of fish by heating fish in an earthen pot with firewood is popular in NEH states of India, Lakshadweep islands, and remote deltas like Godavari and Krishna deltas in Andhra Pradesh. Masmin, Ngari and Colombo cured fatty fishes are some traditional cured fish products commonly prepared in these regions. However, the practice is being discouraged by many on health grounds, as wood smoke quite often contains a carcinogen, benzopyrene. Also, long term and frequent exposure to wood smoke creates respiratory and eye ailments. ICAR-CIFT has developed an eco-friendly model of a community smoking kiln (Green kiln) popularly known as COFISKI, which ensures more shelf life of over six months to the smoked fish. The smoke cured fish products of COFISKI were free from human pathogenic bacteria such as *Salmonella*, *Shigella* and *E. coli* and harbored very few number of hygiene indicator bacteria viz., fecal Coliforms, fecal *Streptococci*, Coagulase positive *Staphylococci* making it safe and fit human consumption. In traditional fish smoking kilns curing of fish are confined to individual family, whereas, COFISKI inculcated community feeling among the fisherwomen in all the villages under adoption. Thus removing socio-economic barriers and tackling the problem as one group instead of solving alone.

***Smart processing and packaging technologies - A leap towards energy efficiency***

Seafoods are highly perishable and usually spoil faster than other muscle foods. They are more vulnerable to post-mortem texture deterioration than other meats. Freshly caught fish undergoes quality changes as a result of autolysis and bacterial activity. Extent of these changes with time determines shelf life of the product. The novel non thermal technologies like high pressure processing, pulsed light, ultrasound, irradiation etc. find application in preservation of food and are in the line of commercialization. Microwave processing is a thermal processing aid, which has gained wide popularity owing to the rapidity of the process and applicability to a large category of products. Recent trend is to employ these techniques in newer combinations that can deliver effective preservation, without the extreme use of any single technique. These techniques aim at inactivation of microorganism rather than inhibiting them. Another interesting application in the development of ingredients and finished products is the functional modification of the food macromolecules that help the processor to have outstanding quality, with reduced cost, time and energy. The new technologies now introduce more possibilities in non-thermal or mild heat alternatives to the conventional heat processing.

***High pressure processing:***

High pressure processing (HPP) is a non-thermal processing technique, which uses very high pressures of more than 100Mpa to preserve food by inactivating microorganisms, spoilage enzymes and alter the food attributes, in order to achieve consumer-desired qualities. HPP was initially adopted for processing beverages and semi-liquid food items, but now this has been one of the most explored technologies and today it is a commercial reality (Fig.5). Usually the product is packed in flexible packages before processing and preferably kept in refrigeration after processing. The major attraction is that the nutritional or sensory qualities of the product are retained and thermal ill effects are avoided. This technology is used in the area of seafood safety that led seafood processors to explore high pressure technology in product development and extension of shelf life. Oysters, clams, mussels, lobsters, crabs, shrimp, cod, hake, ready to eat (RTE) seafood meals, are some examples of products that are currently being processed with HPP. A potential application of HPP is for shucking bivalves (complete separation of meat from the shell) providing high yield of product without any mechanical damage. This technology could open up the new areas of product development and product improvements in all segments of meat and fish industry. Another approach in food industry is pressure assisted freezing and thawing, which finds its unique application in product development and product quality improvement. Since HPP has minimal detrimental impact on thermally labile bioactive compounds the technology is becoming a topic of major interest for cosmetic, nutraceutical and pharmaceutical industry. Salient findings of HPP in work done at ICAR-CIFT areas follows: Indian white prawns were subjected to pressure levels of 150, 200, 250 and 300MPa with holding time at 5 min at 25 °C and subsequent stored in iced condition for shelf life evaluation. 250 MPa had a shelf life of 30 days with respect to physical and biochemical parameters. Yellow fin tuna chunks were subjected to 150, 200 and 250MPa with holding time at 5 min at 25°C and subsequent stored in iced condition for shelf life evaluation. 200 MPa had a shelf life of 30 days. Evaluation of gel strength of fish mince (unwashed) and surimi (single washed) by high pressure treatment were carried out and HPP treated had positive effect on the gelling property of sausage.

***Pulse light technology:***

This non thermal preservation technique uses very high-power and very short-duration pulses of light emitted by inert gas flash lamps to decontaminate and sterilize foods (Fig.6). A spectrum of white light from UV wavelength of 200nm to infrared wavelength of 1100nm is used. Exposure to PL is in the form of high intensity UV light pulses resulted in microbial inactivation through a photochemical, photothermal, and photophysical route. Hence an effective microbial inactivation is achieved, without any adverse effect on the product properties. The application of pulse light has been conducted in various foods but only few studies have been reported in fish and fishery products. The use of pulse light for the sterilization of packaging material is a growing area of food research.

***Pulse electric field technology:***

PEF uses high voltage short pulses to preserve the food, so as to inactivate microbes with minimal effect on quality attributes of the product. It is one of the most appealing technologies due to short treatment time (typically below 1 second); hence, foods treated this way retain their fresh aroma, taste, and appearance. It is suitable for preserving liquid and semi-liquid foods. Application of PEF technology has been successfully demonstrated for the pasteurization of foods fish soups, tomato juice and liquid eggs. Application of PEF processing is restricted to food products with no air bubbles and with low electrical conductivity. PEF is a continuous processing method, which is not suitable for solid food products that cannot be pumped.

***Irradiation:***

Irradiation (gamma rays, X rays, and electron beams) process exposes the food to controlled levels of ionizing radiations which is detrimental to harmful bacteria, pests or parasites. The food packed is passed through the radiation chamber on a conveyor belt and exposed to radiations, without direct contact with radioactive material. Effect of irradiation on nutritional quality depends on the type of food and the dosage of radiation used. It can be used to prolong the shelf life of fruits and vegetables by inhibiting sprouting and delays ripening**.** Irradiation produces some chemical changes, which, although lethal to food-borne bacteria, do not affect the nutritional and sensory quality of the food but lead to the production of small amounts of radiolytic products.

***Ultrasound Processing:***

The application of ultrasound in food processing is another area in non thermal approaches, which exploits the preservative effect of the high intensity sound waves. The treatment enhances shelf life of product with greater homogeneity and energy savings. The preservative effect is by the inactivation of microbes and spoilage enzyme by mechanical actions. Ultrasonication (application of ultrasound at low temperatures), thermosonication (application of ultrasound at high temperatures), manosonication (application of ultrasound and pressure together) and manothermosonication (combined application of ultrasound, pressure and heat) are the various categories of ultrasound processing techniques. The technology finds its application in the field of extraction of proteins, lipids and their functional modifications, emulsification, viscosity improvement, homogenization and improvement of dispersion stability in liquid foods. Ultrasonics has been successfully used to inactivate *Salmonella* spp., *Escherichia coli*, *Listeria monocytogenes*, *Staphylcoccus aureus* and other pathogens. Ultrasound technology can be effectively used for freeze thawingof foods without generation of excessive heat.

***Microwave processing:***

Unlike non-thermal processing techniques, microwave processing involves generation of heat. Still it is attractive due to its instantaneous and rapid increase in temperature, controllable heat transmission, and easy clean-up opportunities. It is currently being used to replace or complement conventional processing technology for pasteurising or sterilising food products as well as to meet the demands of on-the-go consumers who want quick food preparation and superior taste and texture. The largest use of industrial microwave processing of food has been for tempering of meat for further processing. Conventional tempering techniques take a lot of time with considerable drip loss resulting in loss of protein and quality and economic loss. The microwave tempering can be performed in few minutes for a large amount of frozen products (5–10 min for 20–40 kg). Currently, most food industries use microwave at 915 MHz for tempering purposes. Applications of microwave drying include microwave assisted hot air drying, microwave vacuum drying and microwave freeze drying. Microwave heating is found to be an ideal system for cooking bacon and sausages, a sit greatly reduces loss of moisture through drip, fat, nutrients, and flavour. Microwaveable foods in suitable packaging materials are being developed by food processers to meet the growing demand. These convenience foods are microwaveable for use at home and away. High-density polypropylene (HDPP) is a suitable for microwave process over other materials since it can withstand the high temperature.

***Modified Atmosphere Packaging:***

Modified atmosphere packaging is a technologically viable method to extend the storage life of fresh seafood products. In modified atmosphere packaging air is replaced with different gas mixtures to regulate microbial activity and /or retard discolouration of the products. The composition of the gas mixture changes from its initial composition as a result of chemical, enzymatic and microbial activity of the product during storage. It is primarily the enrichment of carbon dioxide in the storage atmosphere as a means of controlling microbial growth, which results in the extension of shelf life of products. Packaging materials generally employed for this purpose are flexible films of nylon/surylyn laminates, PVC moulded trays laminated with polythene, polyester/low density polythene film etc. The use of high barrier film along with MAP that contains $CO_2$ effectively inhibits bacterial growth during refrigerated storage of packaged fresh fishery products. On the other hand, oxygen can inhibit the growth of strictly anaerobic bacteria like *Clostridium botulinum* although there is a very wide variation in the sensitivity of anaerobes to Oxygen. It is also seen that inclusion of only some Oxygen with Nitrogen or Carbon dioxide will not prevent botulism with absolute certainty.

***Active packaging system:***

The concept of active packaging started with a shift in the protection function of packaging from passive to active. It is an innovative concept that can be defined as 'a type of packaging that changes the condition of the packaging and maintains these conditions throughout the storage period to extend shelf-life or to improve safety or sensory properties while maintaining the quality of packaged food'. They can be divided into three categories of absorber (e.g., $O_2$, $CO_2$, odour, ethylene), releasing system (e.g., $N_2$, $CO_2$, ethanol, antimicrobials, antioxidants), and other system. Other active packaging system may include the tasks of self-heating, self-cooling, microwave susceptor, anti-fogging and selective permeable film. The most important active packaging concepts forfishery products include $O_2$ scavenging, $CO_2$emitters, moisture regulators, antimicrobialpackaging, antioxidant release, release or absorption of flavours and odours. Active packaging systems with dual functionality (combination of oxygen scavengers with carbon dioxide and/or antimicrobial /antioxidant substances) are also available nowadays.

***Intelligent packaging systems:***

Intelligent packaging systems provide the user with information on the conditions of the food or its environment. It is a packaging system that is capable of carrying out intelligent functions (such as detecting, sensing, recording, tracing, communicating, and applying scientific logic) to facilitate decision making in order to extend shelf life, enhance safety, improve quality, provide information, and warn about possible problems. The intelligent devices such as sensors, small inexpensive labels or tags that are attached onto primary packaging (e.g., pouches, trays, and bottles), or more often onto secondary packaging (e.g., shipping containers) etc. are the integral part of intelligent packaging system, which facilitate communication throughout the supply chain so that appropriate actions may be taken to achieve desired benefits in food quality and safety enhancement. In contrary to active components, intelligent components do not have the intention to release their constituents into the food.

***Smart packaging system:***

Smart packaging is a broad terminology encompassing both active packing and intelligent packing concepts. Smart packaging offers a number of additional functionalities depending on the type of product, in addition to performing the four basic functions of packaging such as protection, communication, convenience and containment. They help extend shelf life, monitor freshness, display information on quality, improve safety, and improve convenience. The term smart packaging is substituted at times as diagnostic packaging, communicative packaging, functional packaging, enhancement packaging, etc.

***Value addition – processor's opportunity:***

Value added products are the need of the hour, since the consumers find little time for spending in preparing such products. The present day consumers, particularly urban consumers are showing more and more interest in food products which are available as ready to eat or ready to cook. The high level of expendable income and the usage of microwave ovens in households made the value added products an inevitable commodity in the super markets of the urban and even rural area. Obviously, the processors are at a side of great opportunity, as the global demand for convenient products such as marinated fillets, steaks, mince based products, extruded products etc is increasing rapidly. The major opportunities in value addition lie in the following areas:

***Fish mince and mince-based products:***

Fish mince separated from skin, bone and fins are used for preparation of a variety of ready to eat/fry products. Battered and breaded products commonly known as 'coated products' like fish fingers, fish balls, cutlet, patties etc. are the most popular among them. Battering and breading techniques have contributed significantly to value addition of fish and fishery products. These products fetch good demand in domestic as well as export markets as theyrequire minimum financial requirement and are affordable to low time traders.

***Surimi and surimi-based products:***

Surimi, washed mince added with cryoprotectants, also act as an intermediary in development of various products. World-wide, there is a continuous search of raw material which is suitable for surimi production. Low cost white fleshed fishes such as pink perch, croaker and perches can be conveniently used for the preparation of surimi. Even though, surimi and surimi-based products such as sausages are less popular in India, it is a much sought-after item in western markets. Moreover, shell fish analogue products from surimi fetches good demand in domestic and export markets. The Indian company 'Gadre Marine' is a leading manufacturer of surimi, exporting to 24 countries over the world.

***Thermal processing and ready to serve products:***

Long storage life at ambient temperature without any compromise for the nutritional quality made the ready to serve thermally processed products to emerge as a highly demanded commodity. Thermal processing, which is commonly referred as heat processing or canning is a means of achieving long-term microbiological stability for non-dried foods without the use of refrigeration, by prolonged heating in hermetically sealed containers, such as cans or retortable pouches, to render the contents of the container sterile. ICAR-CIFT has standardized the processing conditions for more than 25 product styles, including the ethnic varieties such as Hyderabadi prawn biriyani, Goan mackerel curry, Malabar seer fish curry (Fig.7), Tapioka and fish curry, Seerfish Moli, mussel/oyster masala etc. This technology has a long term impact as evidenced by the adoption of fish products in retort pouch by more than a dozen companies in India. Different types of packaging materials like cans, retort pouches with different layer configurations, semi rigid containers are used for the development of these products.

***Extruded snack products:***

Extrusion helps to improve the versatility for the development of high-nutritive, low cost and convenient food products. It is a thermodynamically efficient process and ensures the destruction of bacteria and anti-nutritional factors during extrusion process. Flavour, texture and taste are the major characteristics affecting the acceptability of these products. Usually, extruded products are prepared using cereal flour, which have less protein content and are limited in some essential amino acids. By incorporating protein-rich fish mince instead of cereal, the product is protein enriched snack food. 'Fish cure' is such a product developed by ICAR-CIFT with fish mince as base material. The flavour and taste of these products may be altered by coating with suitable spice/flavour mix. The production process involves mixing of fish mince with cereal flours, spices and salt and extrusion using a twin screw extruder (Fig.8). The dried and coated products are then packed in metalized polyester polyethylene pouches using nitrogen gas filling. The product is acceptable up to 3 months at ambient temperature.

***Seaweed incorporated products:***

A more recent addition to the food industry from marine sector is 'processed seaweeds and seaweed extracts'. The South-East and North -West coasts of India and the Andaman- Nicobar and Laccadive archipelagoes harbour a variety of seaweeds with rich biomass and species diversity. The seaweed industry is certainly on its way marching towards socio economic development of our nation. Apart from bringing umami taste to foods, seaweeds serve as a major storehouse of polyunsaturated fatty acids, dietary fibres, minerals, vitamins and sulphated polysaccharides in good amounts, which could be used to fortify beverages and health drinks. Dietary fibre extract from seaweeds, 'Nutridrink' (grape juice fortified with seaweed extract), fish soup fortified with seaweed bioactive compound, seaweed incorporated semi-seaweed biscuits (Fig.9) and noodles are a few novel products developed in this line by ICAR-CIFT.

***Fish nutritional bars:***

The new life styles of consumers add to the requirement of new health foods and nutritional energy supplements, in pleasing and portable way. Modern market, have gained a more attraction towards the convenient type nutritional bars/ energy bars/ protein bars in various forms and wide varieties can be made on the basis of different consumer requirement of health food, diet replacer, work out food, energy supplement, geriatric food, sugar free product and nutrient requirement for children. Globally, this trend is being driven by growing consumer awareness about better nutrition in physical performance and personal appearance. ICAR-CIFT has standardized some formulations for nutritional bars added with the best quality supplements from fish source. The protein from fish has been regarded as the high quality with well-balanced amino acid profile, that is easily digestible than any mammalian counter parts. ICAR-CIFT has developed a nutrient formulation with cereal mixes, dried fruits fortified with different biomolecules like high profile fish protein/ collagen peptide/ omega-3 oil in crunchy type granola bars with good shelf stability. Fortification of 10-15% fish protein alone and provide an average energy of 400 Kcal/100g was achieved (Fig.10).

***Processed fish roe and caviar substitutes:***

Fish roes, which form a major component of process discards, are nutritionally valuable sources of omega-3 fatty acids and essential amino acids. Generally, the roe obtained during dressing of fish is either discarded or sold at very low price as it forms a jelly mass during cooking. However, the roe mass may be spray dried using a suitable stabiliser like gum Arabic and the powder can be added to a wide range of foods without affecting the sensory characteristics of the products. Besides the commercially available roe from sturgeon, salmon and cod, fish caviar substitute from fresh water carp roe reconstituted with suitable gelling agents such as sodium alginate will have a greater potential as fish caviar substitutes.

***Miscellaneous products:***

A variety of products like fish sauce, fish salad, fish pickles, frozen whelk, squid fillet, shrimp skewer, stuffed squid with shrimp etc. have fairly good movement in domestic and foreign market. Canned crab, chilled pasteurised crab, crab cut, frozen 'snap and eat' legs are some of the crab based products available in the market. Identifying live crab exports as a money spinner, the Indian seafood industry is all set to rear mangrove crabs, so as to scale up the export of the crustacean that commands high price in the global market.

***High value byproducts - Wealth from waste***

Nearly 70-80% of the total weight of fish catch is generally discarded as bycatchor processing waste. Global fish waste generation is estimated to be in excess of 75 MMT and in the Indian scenario it is >4 MMT. It is estimated that fish processing waste after filleting accounts for approximately 75% of the total fish weight. About 30% of the total fish weight remains as waste in the form of skins and bones during preparation of fish fillets. Bio-conversion of these wastes is an environmental friendly and profitable option for the utilisation of fish waste. Some viable options for generating wealth from waste are detailed below.

***Fish meal:***

Fish meal is highly concentrated nutritious feed supplement consisting of high quality protein, minerals, vitamins of B group and other vitamins and other unknown growth factors. Fish meal is rich in essential amino acids. It is produced by cooking, pressing, drying and grinding the fish, bycatch fish, and miscellaneous fish, filleting waste, waste from canneries and waste from various other processing operations. The composition of fish meal differs considerably due to the variations in the raw material used and the processing methods and conditions. Better quality fish meal has been a prominent item of export from the very beginning of this industry. BIS has brought out the specification for fish meal as livestock feed for facilitating proper quality control. The proximate composition of fish meal, in general, is protein, 50-60%; fat,5-10%; ash, 12-35% and moisture, 6-10% employed. Around 15% of the global fish meal demand is met from fisheries resources alone. The projected (2030) annual growth rate in fishmeal use in aquaculture is 1.7%, where the current usage is at a tune of 3.9%. The recent development in captive breeding and rearing high value species such as cobia, grouper, pompano, Nile tilapia, lobster, Asian seabass etc. implies that there is a good scope for flourishing finfish and shellfish production through aquaculture in near future. This in turn highlights the bright future of fish meal industry in coming years, as most of these species demand high protein feeds for their optimum growth.

***Fish protein hydrolysate:***

Hydrolysates find application as milk replace and food flavouring. Enzymes like papain, ficin, trypsin, bromelein and pancreatin are used for hydrolysis. The process consists of chopping, mincing, cooking and cooling to the desired temperature, hydrolysis, sieving, pasteurizing the liquid, concentrating and drying (by vacuum or spray drying). The fish protein hydrolysate have desirable functional properties with potential applications as emulsifiers and binder agents; and can used in place of diary based and plant based protein hydrolysates as well as protein powders currently available in market place. The peptides formed by the hydrolysis of fish proteins are proven to have bioactive properties like antihypertensive, antithrombotic, immune modulatory and antioxidative properties. Also, they are good source of nutritional and functional properties. A variety of nutraceuticals from FPH are commercially produced and are available in international markets. Oyster peptide extract developed by ICAR-CIFT possessed antioxidant and anti-inflammatory activities. Similarly, hydrolysate made from squilla meat effectively reduced oil absorption in breaded and battered products, when incorporated in the batter mix.

***Fish collagen/gelatin/collagen peptides:***

Collagen is the major structural protein in the connective tissue. Collagen extracted from fishes can be used in cosmetics, foods, biomedical applications etc. ICAR-CIFT has developed the method for the preparation of absorbable surgical sutures from fish gut. Gelatin is the hydrolysed form of collagen with applications in development of bio degradable packaging, food and pharmaceuticals. Both collagen and gelatin are high molecular weight proteins of approximately 300 kDa, hence a considerable proportion is unavailable to human body for biological functions. Consequently, in recent years, much attention has been paid to the development of small molecular weight peptides from the native collagen with improved biological activities. This can be achieved by the process of hydrolysis in which the native collagen/gelatin molecules are cleaved to small fragments of less than 5 kDa. Currently, collagen peptides are being incorporated in a wide array of food products including protein bars, cereal bars, protein drinks, smoothies, yogurts, cold desserts, soups, cured meats etc. Nowadays, collagen/gelatin peptides have gained increasing attention as these peptides exhibit various biological activities such as antioxidant, anti-hypertensive, anti-human immunodeficiency virus, anti-proliferative, anticoagulant, calcium-binding, anti-obesity, anti-diabetic activities and postponement of age-related diseases. ICAR-CIFT has standardised a protocol for the extraction of collagen peptide from fish scale and bone (Fig.11). Further a nutritional mix based on collagen peptides was developedwith a protein content of 78%. The product is mainly intended for middle aged and old people, ladies and sports-persons who needs a regular supply of collagen for healthy joints and bones. It may also be beneficial for patients suffering from osteoporosis and long-term- nursing home residents where there is a possibility of development of pressure ulcers.

***Chitin:***

The shrimp processing industry in India churns out more than 2 lakh tones of head and shell waste per annum, which can be economically converted to chitin and its derivatives. Chitin is the most abundant polymer next to cellulose. It is a linear polymer of N acetyl-D-glucosamine. Glucosamine hydrochloride can be produced from chitin by hydrolysis. Glucosamine hydrochloride and sulphate are at present marketed as food supplement for the treatment of osteoarthritis. It also possesses other beneficial actions in wound healing and skin moisturization. The deacetylated chitin is known as chitosan. Chitin and chitosan have various applications in agriculture such as in germination of seeds and enhanced protection against pathogenic organisms in plants and suppress them in soil to induce chitinase activity and protenase inhibition, antivirus activity, in micro encapsulationfertilizersandinsecticides. The delivery of drugs and the interactions with living tissues seem to be the major topics of current research on chitosan. Other areas of interest are the antimicrobial action, nerve regeneration, cartilage and bone regeneration, skin and bone substitutes, oral delivery for wound healing etc. Carboxy methylation of chitosan imparts water-solubility to chitosan. ICAR-CIFT has recently standardised the methodology for production of chitin, glucosamine hydrochloride, chitosan and carboxymethyl chitosan. Similarly, collagen-chitosan film from fish waste, developed by the Institute has wide applications in wound dressing and dental surgery.The antioxidant chitosan derivative developed was found to be useful in micro-encapsulating vitamins and ß carotene, so as to give a novel delivery system. Similarly, a biocompatible and biodegradable wound healing formulation, composed of microencapsulated curcumin and hydrogel composite (Succinyl chitosan-fish collagen-poly ethylene glycol) developed at ICAR-CIFT, showed significantly enhanced rate of collagen deposition and hydroxyproline content in wound tissue on 14$^{th}$ day of post wounding as compared to control and standard. Apart from that, free radical mediated grafting of gallic acid, ferulic acid, vanillic acid and coumaric acid onto chitosan were optimised. All the derivatives showed good antioxidant and antimicrobial activities.

***Fish ensilage and foliar spray:***

When the animal farms are very near to fish landing centres it is worthwhile to go for silage production. Fish silage is made from whole fish or parts of the fish to which no other material has been added other than an acid and in which liquefaction of the fish is brought about by enzymes already present in the fish. The product is a stable liquid with a malty odour which has very good storage characteristics and contains all the water present in the original material. It is a simple process and it requires little capital equipment particularly if non-oily fish are used. The use of oily fish usually requires oil separation. This involves expensive equipment and is suited to a fairly large-scale operation. The silage may be suitable converted to foliar spray, as foliar feeding is an effective method for correcting soil deficiencies and overcoming the soils inability to transfer nutrients to the plant. The experiments conducted at ICAR-CIFT have shown that foliar feeding can be 8 to 10 times more effective than soil feeding and up to 90 percent of foliar fed nutrients. The application of foliar spray has been advocated in spices like cardamom, black pepper, tea etc and encouraging results have been reported. The quick absorption of the nutrients and precise dosage of foliar sprays has resulted in the success of precision farming of costly vegetables and flowering plants. The controlled nutritional supply through praying is an effective method which gives predicted resulted in most of the cases. The optimized supply of required micro and macro nutrients results in the maximum productivity of the available space and minimizes the wastage of costly inputs.

***Fish calcium:***

In marine ecosystem, there is a large amount of calcium, mainly in the form of calcium carbonate and calcium phosphate, distributed as skeletal elements of teleosts, exoskeletal elements of molluscs or as coral deposits. Every year a considerable amount of total fish catch is discarded as processing left overs and these include trimmings, fins, frames, heads, skin and viscera The bone fraction, which comprises approximately 15-20% of the total body weight of fish has high calcium content. Calcium and phosphorus comprise about 2% (20 g/kg dry weight) of the whole fish. Generally, fatty fish have lower ash levels compared to lean species. The filleting wastes of tuna and other bigger fishes are very good sources for calcium when the quantity of calcium is concerned. Also, the bone structure differs between species since a large number of teleosts have acellular bone (bone without enclosed osteocytes). Cellular bones are confined to only a few fish groups, e.g. Salmonidae. The higher surface to volume ratio in acellular fish bone is likely to increase the calcium availability compared to cellular bone. The ash content is highest in lean fish species with acellular bones. Apart from that exoskeleton of mollusks and coral deposits are excellent source of calcium. However, the calcium form these deposits are mainly in the form of calcium carbonate. Central Institute of Fisheries Technology, Cochin has optimised the process to extract from fish bone which is mainly treated as processing discards during filleting operation of larger fishes, *viz* tuna, carps etc. The calcium powder was supplemented with vitamin D which is known to enhance absorption and bioavailability of calcium in the body. *In vivo* studies conducted at ICAR-CIFT in albino rats have shown that fish calcium powder supplemented with vitamin D has improved the absorption and bioavailability.

***Chondroitin Sulphate:***

Chondroitin sulphate obtained from shark cartilage is used for the treatment of arthritis. It is part of a large protein molecule (proteoglycan) that gives cartilage elasticity.

***Squalene:***

Squalene is a highly unsaturated hydrocarbon present in the liver oil of certain species of deep sea sharks mainly *Centrophorus* and *Squalidae* spp. The liver oil of these species contain high percentage of squalene (90%) which can be isolated and purified and can be used as a dietary supplement. It belongs to a class of antioxidant molecules called isoprenoids. Squalene is found to be a proficient chemo preventive agent against lung metastasis in mice bearing lung carcinoma. Squalene revives damaged body cells and aids to revitalize cell generation. Its chief attribute is the protection of cells from oxidation reactions. Squalene assists to clean, purify, and detoxify the blood from toxins, facilitating systemic circulation. It purifies the gastrointestinal tract and kidneys, causes better bowel movement and urination. Squlalene helps in regulating the female menstrual cycle and also improves irregular and abnormal cycles. ICAR-CIFT has standardized the protocol for extracting squalene from shark liver oil.

***Hydroxyapatite (HAp):***

Hydroxyapatite is the major mineral component of bone tissue and teeth, with the chemical formula of $Ca_{10}(PO4)_6(OH)_2$. The composition Hap derives from biological sources differs from that of synthetic hydroxyapatite, due to the presence of several ionic substitutions in the lattice, such as $CO_3$, F, $Mg^{2+}$ and $Na^+$. It is a member of the calcium phosphate group with 1.67 stoichiometric of Ca/P ratio. It is one of the few materials, classified as a bioactive biomaterial that supports bone in growth and osseointegration when used in orthopedic, dental and maxillofacial applications. Fish bone and scale is a rich source of hydroxyapatite. The hydroxyapatite content of fish skeleton may vary between 40-60%. Generally, very high heat treatment is used for extraction of HAp from bone and this temperature gives a higher strength to HAp structure. The high temperature also burns away any organic molecules such as collagen protein. Hydroxyapatite, found in fish is chemically similar to mineral components of bone and hard tissues in mammals. Approximately, 65-70% of the fish bone is composed of inorganic substances. Almost all these inorganic substances are hydroxyapatite composed of calcium, phosphorous, oxygen and hydrogen.

***Pigments:***

Astaxanthin, fucaxanthin, melanin etc. from different fish resources are found to have a variety of bioactive properties. The filleting discards of salmonids and the shell wastes of crustaceans contain significant amounts of carotenoid pigments such as astaxanthin and canthaxanthin. The protective role of carotenoids against the oxidative modification of LDL cholesterol could be explored by incorporating in health drinks. Carotenoids are also highly sought after as natural food colours. Cephalopod ink is another less tapped reservoir of a range of bioactives having therapeutic and curative values. It is an intermixture of black pigment melanin, glycosaminoglycans, proteins, lipids, and various minerals. Cephalopod ink has been reported to have anti-radiation activity, antitumor activity, immune-modulatory activity, procoagulant function and so on.The pigment melanin can be used both as a natural colorant as well as antioxidant, in addition to a number of other therapeutic and prophylactic properties including anticancer, antihypertensive, anti IDA etc.

**ICAR-CIFT in quality assurance of post harvest fisheries sector of India**

As fish is a food commodity that has been traded across the world, there is lot of research and development activities carried out by ICAR-CIFT on the quality and safety of fish and fishery products. For ensuring quality and safety of seafood, the Indian

Council of Agricultural Research set up an independent division in 1996 for taking up research, consultancy, training and analytical services in seafood quality assurance. ICAR-CIFT has proved itsexpertise in areas such as seafood quality assurance, food safety, sanitation and hygiene in fish processing establishments, production and evaluation of process water and ice, modern quality management programmes such as HACCP, ISO 22000 and regulatory requirements *viz*., EU regulations, Codex/IS/ISO standards etc. ICAR-CIFT is involved in the Assessment Panel of Experts (APE) and Supervisory Audit Team (SAT) for establishing quality regime in fish and fish based products. Also ICAR-CIFT humbly takes the credit of implementing HACCP in India for the first time in the early 1990s. Some of the salient research activates include microbiological interventions, development of methods for chemical contaminants, different package of practices based on HACCP, withdrawal period of antibiotics, challenge studies of different food borne pathogens, quality index schemes, different chemical hazards, antimicrobial property of phytochemicals etc. ICAR-CIFT is actively involved in developing and implementing an energy efficient effluent treatment plant for the fish processing units within the state and outside.The institute is also providing consultancy in the design, development and getting accreditation as per ISO/IEC 17025:2005. ICAR-CIFT has proudly contributed to the development of standards and the recent one is development of four standards for International Standards Organizations (ISO) for the traceability of both wild and cultured Molluscs and Crustacean. CIFT has taken accreditation as per ISO/IEC 17025:2005 in 2005 and has been doing service to the industry and the needy. The institute has accredited for more than 120 parameters in chemical, microbiological and mechanical areas. The institute is also identified as the quarantine centre for fish and fishery products, for DADF, Ministry of Agriculture.

**Conclusion**

Fisheries is considered as a sunrise sector in India due to its recent renaissance and growth potential. The technological advancements in the harvest and post-harvestsector catalysed by the mechanization of fishing crafts and modern electronic technologies for navigation and fish location, along with energy efficient processing aids, offer good scope for the development of sector. Product diversification, promoting more public-private partnerships, creating more awareness on quality assurance throughout the value chain, taking initiatives for increased infrastructure facilities for market development, awareness creation on responsible and sustainable fishing practices etc. are crucial steps towards achieving ‘blue revolution’.

Fig.1. Rubber wood canoe


Fig.2. Solar-powered boat useful for aquaculture etc


Fig.3.Sagar Haritha': Energy efficient green fishing vessel

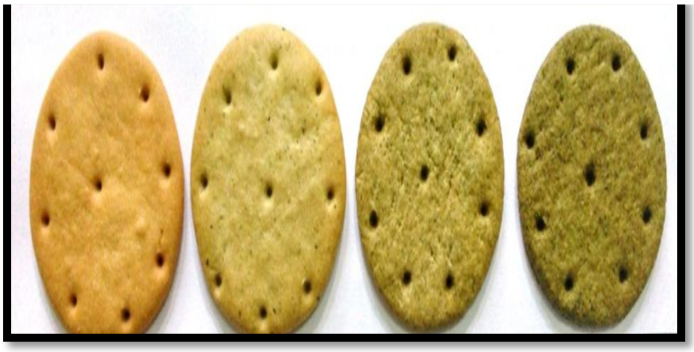

Fig.4. Solar dyer



Fig.5. High pressure processing unit    Fig.6. Pulse light processing unit



Fig.7. Fish curry in retortable pouches    Fig.8. Extruded fish snack



Nutritional bar developed by ICAR-CIFT

Seaweed enriched biscuits developed at ICAR-CIFT

Fig.11.Collagen peptide from fish scale and Nutritional mix formulated by CIFT

## Chapter 2

**Innovative Extension Approaches for Sustainable Fisheries**

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### Importance of global fisheries

Global fisheries have made rapid strides in recent years by establishing its strong hold over increasing food supply, generating job opportunities, raising nutritional level and earning foreign exchanges. These accomplishmentshave become more important when considered in the context of recent challenges in food production, nutritional security, social changes and growing climatic hazards. Fish and fishery products are the most traded food commodities in the world accounting for 1% of world merchandise tradein value terms representing more than 9% of total agricultural exports all over world (FAO, 2014). About 38% of the global fish production enters international trade in various forms and shapesaccounting for export earning of nearly US$148.1billion with a record import at US$140.6 billionduring 2014. The value of the global fish trade exceeds the value of international trade in all other animal proteins combined. Mostly the developing countries that account for over 60% of global fish catch, which is continued to expand at an average annual rate of 8.8%(FAO, 2009 & 2012),play a major role in the global trade of fish and fish products; about 50% of all fishery exports in value terms and more than 60% in quantity terms are supplied by them (World Bank 2011). At the same time, demand for fish products are likely to rise as a result of rising populations that are expected to reach 9.3 billion by 2050. Furthermore, developing countries now display a positive trade balance due to their increasing involvement in global fisheries trade.Developing country like Indiamay have higher proportion of population growth but it's impressive economic growth over the past two decades has resulted in steady increase in per capita income in real terms that in turn increases the purchasing power of people resulting in increasing demand for food to feed & ensure nutritional security of the population. As a result of which it brought inconsistency in fish consumption pattern across the coastal, marine and hill region.

It is estimated that fish production generally contributes 0.5 – 2.5 % of GDP globally (Allison 2011). In spite of that globally an estimated more than 1.3 billion people are in extreme poverty (2016), 795 million people (2015-16) are estimated to be chronically hungry and an estimated one third of children in the developing world under five years of age are stunted (Conway 2012). Fish is considered as the most affordable and frequently consumed animal-source food in low income food deficit countries in sub-Saharan Africa, Latin America and Asia (World Bank,2006) , which is an important source of a wide range of intrinsic micronutrients, minerals and fatty acids. It accounts for about 17 % of most affordable, easily digestible, high-quality animal protein and 6.7 % of all protein, all essential amino acids, essential fats (e.g. omega-3 fatty acids), vitamins and mineralsthus contributing to a great extent to food and nutrition security in many Asian and African countries where large numbers of people are still under starvation and under nourished (Kent,1987). Besides small-sized fish species are excellent source of many essential minerals such as iodine, selenium, zinc, iron, calcium, phosphorus, potassium, and vitamins such as A, D and B. About 150 g of fish provides about 50–60 % of daily protein requirements for an adult. On an average, fish provides about 20–30 kilocalories per person per day. In addition, dietary diversity of the region is mainly influenced by different quantitative and qualitative attributes viz., income, price, preference, market, type and quality of products, cultural traditions, beliefs as well as various geographical, environmental, social and economic factors that influences the fish consumption pattern.

Despite the important contributions by the sunrise sector, global debates on fisheries issues and policies appear to be dominated by concerns over environmental sustainability, overfishing and overcapacity. In this context, it is alarming to note that the sector did not receive adequate attention from the social scientists to understand its various socio-economic dynamics to prove the sunrise sector fisheries as a potential driver of local and national economic development.

**Major concerns in fisheries**

Food security has become the prime concern with the increasing trend of population growth in a country. Over the last fifty years, the food grain production in India has increased considerably, but the advantage of this increase in foodgrain production has not beenreflected in the percapita availability of food grains. As per estimate, the human population and food grain production in India was grown up by 2.09% and 2.36%, respectively from 1961 to 2011, whereas the annual per capita availability of food grains was come down from 171.1 kg in 1961 to a level of 169 kg in 2011 showing a decreasing trend of 1.17 %. In case of fish, Asia accounts for almost two-thirds of global fish consumption i.e. 21.4 kg per capita in 2011 – a level similar to Europe (22.0 kg/cap/yr) and North America (21.7 kg/cap/yr), and close to the levels of Oceania (25.1 kg/cap/yr). Africa, Latin America and Near-East have lowest per-capita consumption (10.4, 9.9 and 9.3 kg/cap/yr in 2011, respectively). Although annual per capita apparent consumption of fish products has grown steadily in developing regions (from 5.2 kg in 1961 to 17.9 kg in 2011) and in LIFDCs (4.4 kg in 1961 to 8.6 kg in 2011), it is still considerably lower than in developed regions (from 17.1 kg in 1961 to 23.0 kg in 2011). It is clearly evident that rising population is nullifying the effect of growth in food grain production, keeping aside several other factors which determine the access to food grains.In this context, increasing fish production to meet the challenges of nutritional security has drawn the attention of the planners and policy makers. In this context, aquaculture is considered as a promising food production sector for high quality protein food and providing livelihood to the rural populace. Hence, it is essential to make it more efficient and cost-effective. However, there is multitude of challenges associated with the growth of this industry.

The fishery sector is a major foreign exchange earner for any developing countries. In India, its foreign exchange earnings were estimated to increase by 16 to 20 per cent by 2005 and 26 to 42 per cent by 2015. In view of higher production in fisheries, producers may lose from price fall in the domestic market; where prices were estimated to fall by 15 to 20 per cent by 2005 and 27 to 54 per cent by 2015. Nearly 85 per cent of the export benefits are projected from shrimp export alone. Because of its potential and rich source of animal protein, fish demand has been rising in both the developed and developing world at more than 2.5 percent per year (Peterson and Fronc, 2007) and demand levels were raised in proportion to increase in income in highly populated countries like China and India, (Garcia and Rosenberg, 2010).In spite of the phenomenal success of the sector, still there are concerns for the economic and nutritional conditions of fisher folk in addition to some important concerns in the context of rising environmental hazards, depressing prices world over, emerging new economic order following establishment of WTO, IPR & SPS issues, compliance of several multilateral agreements, etc.

In the post- harvest front, the processing industries used to face the problems of complicated exporting procedures, high shipping costs, cut-throat competition in the industry, changing quality standards of importing countries, irregularity in supply of raw materials, hygiene problems and non-availability of quick transportation facilities from the fishing port to the processing units, etc. As a result of which trade-driven commercial fish farming is suffered that reduce the livelihood opportunities of small scale dry fish processors, petty traders within the communities and poor fishermen.

Environmental degradation poses a challenge to the phenomenal success of the fishery sector in promoting food security and adversely creates impact on nutritional rights and livelihood of the fishermen communities for whom fish and fishery products are critical to health and wellbeing. As per directives of international conventions like Kyoto Declaration and Code of Conduct of Responsible Fisheries, this trade-driven, resource depletion sector can be sustained through by-catch reduction and ban on juvenile fishing. The benefit of this may be accrued through policy level intervention by institutions within the legal framework.

Small-scale fisheries are normally characterized by low capital input activities, low capital investments and lack of equipment, labor-intensive operations followed by traditional fishers. They also usually operate as semi-subsistence, family-based enterprises, where a share of the production is kept for self-consumption (Garcia et al., 2008). Traditional fishers dominate the marine sector and they are socially deprived, educationally weak with very high occupational rigidity. There is inequity in the distribution of yield and effort in marine fishing. They are unorganized with least social security benefits. The informal social security system in the form of sharing of earnings for the community and social organizations prevailing in the traditional fishing is absent in the mechanized fishing. There are also huge regional variations in productivity.

Technologies are the main drivers of growth. Hence, systematic technological interventions backed by adequate policy and institutional support are vital for making the aquaculture operations sustainable and economical. Generally, the technologies and trade interventions reinforce each other which can be characterized as skill-based, cost effective, capital intensive which can bring a change in the performance of the sector. Following strategies have been suggested for an accelerated fishery development with focus on poverty alleviation of poor fishers:

-  Commodity-centered approach
-  System approach
-  Prioritize technology on the basis of needs and problems at micro and macro levels
-  Innovate and strengthen institutions and policies
-  Upgrade the skills of the fishers
-  Enhance investment and reorient policies to facilitate percolation of benefits to all sections of the society.
-  Follow ecological principles
-  Emphasize on domestic market demand and consumers' preferences
-  Monitoring the technology demonstrations programs and assess the impacts.
-  Strengthen database and share it for a better planning and policy making inthe sector.

Extension systems for sustainable development

Unlike India, the economy of developing and underdeveloped countries in sub Saharan Africa, Latin America, Asia inclusive of 22 Low Income Food Deficit Countries (LIFDCs) is predominantly agrarian economy where agriculture sector provides employment and livelihood to majority of the rural households, but the condition of both farmers and farming is in alarming state.

Agriculture stands on the very complex interaction between biological, climatic and geographical factors in addition to human activities. The information under such a complicated system is unpredictable, unstable, subjective, site specific and reliant on empirical decision given the inherent variability of biological phenomena. In spite of nation's priorities and developmental strategies for reducing poverty, hunger and ensuring quality of life to its people, we are still lagging behind in human development index as expected. People particularly small, marginal and landless farm households are still far from the reach of good education, nutrient nourished diet, better health care facilities and modern age amenities.

Hence, there is an urgent need to reform agriculture inholistic, scientific and systems approach to meet the present day challenges in agriculture due to climate change and global competitiveness so as to achieve sustainable agriculture production and growth under different agro-climatic conditions.

In agricultural parlance, sustainability means maintaining the crop productivity without enhancing input levels. Sustainable agriculture is a form of agriculture aimed at meeting the needs of the present generation without endangering the resource base of the future generations. According to the concept laid by the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR)

“Sustainable agriculture is the successful management of resources for agriculture to satisfy the changing human needs, while maintaining or enhancing the quality of environment, and conserving natural resources”. Sustainable agricultural systems must be resource-conserving, socially supportive, commercially competitive, and environmentally sound. Hence, the agriculture research system must place emphasis on generation of required technology along with strong linkage between research-extension system and vice versa. It involves design and management procedures that work with natural processes to conserve all resources, promote agro-ecosystem resilience and self-regulation, minimize waste and environmental damage, while maintaining or improving farm productivity and profitability (MacRae et al., 1990).

The role of extension in agricultural system cannot be ignored. Strong extension system is the key to the desired change to meet the present day challenges in agriculture. Basically the end product of the extension system is to work with farmers within a climate and economic environment by providing suitable technologies to widen their horizon, enriching knowledge and upgrade skills to improve better handling of natural farm resources and applying scientific production technologies to achieve desired production level. Extension system plays a pivotal role in empowering farmers and other partners to make it more farmers’ participatory, demand-driven, knowledge oriented and skill supportive for disseminating most appropriate technical, management and marketing skill to improve profitability in agriculture that can overcome the emerging challenges and concern thus developing a synergistic pathway for enhancing productivity along with quality produce in order to sustain production base and ecological and livelihood security. The extension system needs to disseminate a broad array of information starting from seed to seed, field to fork in an integrated manner for safe delivery from field to the consumer concerning all the aspects of conservation and production technologies, post-harvest management, processing and value addition. Such knowledge based decision should be incorporated in reshaping of extension approaches. In present scenario, the extension system envisages a transformation from technology driven to market driven extension where farmers would give emphasis on commercialization of high value products, maintenance of quality control, fulfilling market demands, cost effectiveness etc. thus economic indicators become theme to the program planning process for the effectiveness of any programme.

With the advent of global competitiveness and market liberalization, our prevailing extension system has to be strengthened with innovative extension approaches to tacklethe recent challenges in agriculture viz., climate change and weather aberrations, dwindling resources and population stress, so that farmers can adjust their production portfolio keeping eye upon the emerging trends in food consumerism in domestic as well as global markets. Grooming farmers with information supportfor taking right decision to improve their production in agriculture and allied fieldsessentially requires a strong network of extension systems, along with government initiatives and strong linkage among extension scientists and functionaries working for agricultural development. This would ensure the livelihood security of millions of farmers by improvingthe quality production and creating of better job opportunities in rural areas,which intends to bring out planned changes to meet the needs of the present generation without compromising the future generation's requirements.

**Innovative extension approaches for technology dissemination**

Earlier, in developing countries, the extension personnel were involved in diffusion of farm technologies generated by public research organizations, mostly disseminated through appropriate mechanism, viz., On Farm Trials (OFT), frontline demonstrations (FLD), field visits, farmers' meetings, media use, etc. This process had the conceptual backup from the 'diffusion of innovation' model. But, in the last two decades, the paradigm shifts in development pivots to the enhanced concern for future generations to meet their basic needs, accordingly the nature of agricultural technology design and integration is drawing attention of the extension professionals and practitioners across the globe. In India, different models for transfer of farm technology have been tested and also robust extension education approaches have been validated. Furthermore, the frontline extension system of the country has been sharpened through more farmer-centric approaches for technology adaptation and dissemination. The extension system in India has been designed to move beyond technology and beyond commodity through ensured reciprocal farmer-research-extension linkages. Farm producers located at far-off and those unreached still suffer from lack of access to appropriate services like credit, inputs, market, extension, technologies etc. Keeping eye upon this, the World Development Report had focused on need to restructure and revamp agricultural extension system as a pivot for realizing the growth potential of farm sector against the widening demand–supply pressures for ensuring sustainable, inclusive, and pro-poor agricultural and economic development. Therefore, farmer's participatory technology development and client's participatory extension approaches emerged as a part of integration ofthe 'interdependence model' and the 'innovation systems framework' that offered more inclusive ways of involving the institution in technology generation, diffusion and use of new knowledge. Extension approaches have to be redefined depending upon the components involved for sustainable growth and livelihood security of the farmers for which a conceptual framework has to be developed in response to recognizing and considering different livelihood assets viz., human, social, physical, natural and financial resources. Some of the following innovative extension approachesoriginating from multiple sources must be adopted on trial basis to make agriculture more profitable to provide food, nutrition and livelihood security to farmers, which can be replicated in the fishery sector interwoven with numerous issues including increased production with sustained natural resources, growing market demand for processed products having entrepreneurial opportunities, protection and conservation of environment, and even international trade.

An analysis of national extension systems in the Asia and Pacific region by Qamar (2006)observes that agricultural extension is undergoing a major transformation as a result of failure of public extension systems perceived to be outdated in the context of globalization, decentralization, and information technology revolution. Extension systems in many developing countries are undergoing a paradigm shift to more farmer-oriented approaches to rural innovation that emphasize the importance of interactive, integrated and multidisciplinary oriented mutual learning between formal and informal knowledge systems(Friederichsen, 2009).

a.**Asset Based Community Development (ABCD) approach**

As per the traditional approach to development, poor people see themselves as people with special needs that can only be met by outside supporting agencies. But Asset Based Community Development (ABCD) approachintends for the development of community based on the principle of identifying and mobilizing individual and community 'assets', rather than focusing on problems and needs.It is an extension approach in which a community's micro-assets are linked with its macro environment. It believes that communities can initiate and sustain the process of growth and development themselves by recognizing and harnessing the existing, but often unrecognized assets, and thereby promoting local economic potential to drive its development process (Rans & Green, 2005). The approach is optimistic in nature, because the focus is on what is possessed by the community, rather than the problems of the community.

The focal point in this approach is asset and not the need of the community. Assets of individuals, associations and institutions are identified after an extensive survey and assets are then matched with the need of the people to empower communities to control their futures and create tangible resources such as services, funds and infrastructures etc.(Foot and Hopkins, 2010. In agriculture, ABCD approach gives greater emphasis on reducing the use of external inputs and on a high degree of social mobilization in which the assets of the poor (social, physical, financial as well as human) can be utilized to bring sustainable livelihoods through variety of different agricultural and non-agricultural activities.

**Five Key Assets in ABCD**

As per ABCD approach there are 5 categories of asset inventories such as individuals, associations, institutions, physical assets and connections

1. Individuals: Every individual has got certain assets, gifts and qualities; such individual is at the center of ABCD approach.
2. Associations: Groups of people working with a common interest are critical to community mobilization.
3. Institutions: The assets of institutions help the community capture valuable resources and establish a sense of civic responsibility.
4. Physical Assets: Physical assets such as land, buildings, space, and funds are other assets that can be used.
5. Connections:These are the exchange between people sharing their assets by various methods.

b.**Rural advisory services (RAS)**

Rural Advisory Services (RAS) refer to all the different activities that provide the information and services needed and demanded by farmers and other actors in rural settings, to assist them in providing their livelihoods by developing their technical, organizational and management skills and practices (GFRAS, 2011; FAO, 2010). RAS designers and implementers must recognize the diversity of actors in extension and advisory fields (public, private, civil society); the need for extending support to farmers' producer organizations (FPO) and rural communities (beyond technology and information sharing) including advice related to farm, organizational and business management; and explaining the role of facilitation and brokerage in rural development and value chains. In the case of aquaculture, large-, medium- and small-scale farmers need different types of RAS support. The large farms are mostly self-reliant and need only regulatory support, while medium-sized farms need mobilization and facilitation support in addition to regulatory support. Small aquaculture farms need more education and input provision alongside facilitation (Kumaran, 2014).Timely sharing of research recommendations can address the problem of disseminating information to farmers. In this direction, innovative strategies are being formulated keeping the farmers' needs and capacities in mind to pass on appropriate technologies by combining Internet, telecommunications, video, and print technologies that may bridge the information gap and empower farmers to make better production and marketing decisions (McLaren et al. 2009).

**In fishery sector, RAS helps in**

- Providing management and business development support appropriate to the scale, resources and capacities of each fisherman.
- Better understanding markets (prices, seasonality, standards, value addition etc.) related to fish and fish products.
- Linking fishers to other stakeholders involved in provision of varied support and services.
- Creating platforms to facilitate interaction and sharing among the various stakeholders including FPOs to ensure coordinated support to fishers.
- Exploiting information communication technologies (ICTs) to provide fishers with a range of information related to weather, prices, extension programmes and generic information regarding fisheries.
- Facilitating the formation of FPOs and also collaborate with FPOs to strengthen the demand and supply side of RAS.
- Promoting institutional and policy change to enable and support small-scale fishery.

RAS encourages the formation/ organisation of groups by involving individual family farmers, who have little influence over the social, economic and political processes affecting them, but as a group/ organizations and networks they can deal with their specific challenges and make their voice heard. Such groupings can act as platforms to articulate concerns, exchange knowledge, influence policies and engage in collective action so that their agriculture remains sustainable and profitable. Effective formation of Rural Resource Centres (RRCs), Fishermen Cooperative Society, Farmers producers Organisations(FPOs) can be instrumental by galvanizing collective action in order to ensure better access to markets and to support innovation by their members in related activities (Sundaram, 2014).

**c.Model Village System of Extension (MVSE) approach**

MVSE is an integrated and holistic extension approach where community participation was prioritized for suitable technological interventions in the farmers' field to bring all round development in agriculture and allied sectors in the community in terms of socio-economic upliftment, technological empowerment, self-governancethereby enhancing the futuristic knowledge base and skills through participatory framework. MVSE emphasized oninvolvement of all stakeholders in the process to converge their activities with a stake in the food value chain linking producer to consumer. Nevertheless, MVSE is an action research taken up in farmers' field based on the principle of leveraging the activities, investments and resources from outside agencies/ externally aided projects resulting higher productivity, ensuring food security and sustainable improvement in overall quality of life by promoting leadership, self-dependency of the community in food chain.Economically viable, ecologically compatible and socially acceptable suitable technologies were successfully intervened in farmers' field in a cluster adopted as model village through participatory mode by integrating the multi-disciplinary research which was later replicated to other villages. The village was developed as a commodity village branding for a particular commodity in the market.

MVSE approach works on the following principles:

- Promotes self -governance among the farmers
- Skill improvement and leadership development among the community members.
- Establishing linkage through pluralistic convergence of different stakeholders associated in the sector.
- Encouraging the market opportunities through commodity based village development.

d**. Farmers Field School (FFS) approach**

This extension approach is an alternative to the top down extension approach which was evolved as a method to solve complex field level issues in agriculture and allied sectors. The FFS approach is an innovative, participatory and interactive learning approach that emphasizes problem solving and discovery based learning. FFS also provides an opportunity for farmers to practice and evaluate sustainable land use technologies, and introduce new technologies by comparing with their conventional technologies developed in congruent with their own tradition, culture and resource use pattern.FFS, considered as a farmer-to-farmer extension approach, aims to build farmers' capacity to analyze their production systems, identify problems, test possible solutions, and eventually encourage the participants to adopt the practices most suitable to their farming systems (FAO, 2003 c). This is a learning-by-doing approach which emphasizes group observation, discussion, dissection, modification, and promotes field-based experimentation, analysis for collective decision making followed by actions. The goal of the approach is such that, after observing and comparing the results of field level experimentation farmers will eventually "own" and adopt improved practices by themselves without any external compulsion. Field day is being organized at the end of the season to give visibility to the entire activities to convince the non-adopters. Exchange visits with other FFS is also encouraged to learn by association and comparison A group of 20-25 farmers can form a farm school under the guidance of a FFS facilitator. Extension workers, NGO workers, farmer organization staff or previously trained farmers can become Farmer Field School facilitators. The facilitators are trained by master trainers, who have expertise in the particular subject matter. FFS is a time bound activity usually covering one production cycle or a year.

It is also significant to note that irrespective of the merits of the technology, farmers' acceptance to them is influenced by the extension method. Farmer Field School (FFS) model has been accepted as a good methodology because it is exclusively participatory. A comparison was made between a 6-year participatory seed selection and multiplication project in Nepal and a 3-year seed distribution relief program in Zimbabwe. The study revealed that the project in Nepal was successful in its scaling up and continuity as the new varieties of crops increased yields by about 45% and improved stability in household food access. In contrast, only 12% of the beneficiaries in Zimbabwe decided to reuse and plant the open pollinated maize varieties the following year because the new varieties were not properly appreciated by the farmers because they had not received sufficient information and training on seed selection (Ministry of Foreign Affairs of the Netherlands, Policy and Operations Evaluation Department 2011).A special feature of this extension approach was that it reached poor and female-headed households and lower-caste households much better than the regular extension services (Tiwari et al. 2010). Other barriers to the adoption of sustainable agriculture practices include social barriers, infrastructure, and incompatibility of technology.

The basic component of FFS is setting up of a Participatory Comparative Experiment (PCE), commonly referred to as Participatory Technology Development (PTD), whereby the farmers put the FFS concept into practice under close monitoring and supervision by the FFS members. A PCE can be developed in the field of agriculture, livestock, fishery, forestry, agro-forestry, livelihoodsystem and others.Principles of Farmer Field School(FFS)are as follows:-

- Field is the learning place.
- Emphasizes hands on and discovery based learning.
- Farmers become experts.
- Integrated and learner defined curriculum.
- Doing is better than learning/ seeing.
- Experiences are the start of all learning.
- Link to actual field situations and should be relevant to local needs and problems.
- Participatory monitoring and evaluation.
- Farmers are decisionmakers.

e. Market led extension approach

In order to make agriculture more enterprising, extension professionals need to be pro-active beyond the regular objective of maximizing the productivity of the farmers/producers by transferring improved technologies rather farmers should be sensitized on various aspects of produce like quality, consumer's preference, market intelligence, processing and value addition and other marketing information.This will help the farming community to realize high returns for the produce, minimize the production costs, and improve the product value and marketability that may lead to realize the concept of doubling farmers' income.With the globalization of agriculture, emphasis on productivity and profitability to the farm enterprises increased and, therefore the demand driven agriculture (and allied sectors) has led to the paradigm shift from production-led extension to market led extension. There are many challenges in the agricultural marketing system which can be resolved through the efforts of market led extension models.

In this approach farmer/producer is viewed as an 'Agripreneur' who expects high returns 'Rupee to Rupee' from his produce by adopting a diverse baskets of package of practices suitable to local situations/ farming systems with optimum cost benefit ratio (C:B ratio) ensuring maximum share of profit by exploring the market demand. Goal of market led extension is to facilitate farmers to get. Market led extension focuses on harnessing the ICT tools to access market intelligence including likely price trends, demand position, current prices, market practices, communication network, etc. besides production technologies.

For farmers, as the extension system is more credible source of farm technologies, the extension personnel ought to be knowledge- and skill-oriented in relation to production and marketing of agricultural goods. Thus, revamping the extension system will have a catalytic role for ushering in farmer-led and market-led extension; which can subsequently alleviate poverty and ensure livelihood security. In the light of this, the challenge remains to motivate the extension personnel to learn the new knowledge and skills of marketing before assigning them marketing extension jobs to establish their credibility and facilitate significant profits for the farming community.SWOT analysis of the market, Organization of Farmers' Interest Groups (FIGs), capacity development, establishing linkage and synergy, harnessing ICTs, digital marketing etc are the competencies required by the extension personnel in order to effectively implement market led extension.

**f. Digital extension approach**

Extension reforms brought a transformation in agricultural extension system through introduction of Information and Communication Technologies (ICTs). The ICT-enabled extension systemreferred to as Digital Extension has the potential for enabling theempowerment of farming communitiesby improving their access to information and sharing knowledgewith innovative e-agriculture initiatives (Saravanan, 2010a).

With the phenomenal growth in information and communication technology, use of IT application in agriculture will bring remarkable change in the attitude and knowledge level of user. Basic requirement is to provide most appropriate information in such a capsule that can be easily understood and used by them. This approach will strengthen the extension system for better dissemination of technology. As acase study the contribution of Digital Green, a NGO that uses an innovative digital platform for community engagement to improve lives of rural communities across South Asia and Sub-Saharan Africa is remarkable. Digital Green associate with local public, private and civil society organizations to share knowledge on improved agricultural practices, livelihoods, health, and nutrition, using locally produced videos and human mediated dissemination. As per the study, the Digital Green project (participatory digital video for agricultural extension) increased the adoption of certain agriculture practices seven times higher compared to traditional extension services and the approach was found to be 10 times more cost-effective per dollar spent.Hence, along with ICT-based advisory services, input supply and technology testing need to be integrated for greater impact and content aggregation from different sources require to be sorted in granular format and customized in local language for rapid adoption of technologies (Balaji et al., 2007&Glendenning and Ficarelli, 2011).

The effectiveness of this innovative extension approach depends on capacity building, people's participation along with government initiative to provide strong infrastructure to be worked with the cutting edge technologies. The farmer friendly technology dissemination process needs to be handled with careful planning by the incorporation of information communication technology. The use of ICT application can enhance opportunities to touch the remote farmers to live in close proximity of the scientific input. The computer based web portals namely aAQUA, KISSAN Kerala, TNAU AGRITECH Portal, AGRISNET, DACNET, e-Krishi, ASHA, India Development Gateway (InDG) portal, Rice Knowledge Management Portal (RKMP), Agropedia, KIRAN, AGMARKNET, ITC-e-Choupal, Indiancommodities.com, Mahindra Kisan Mitra, IFFCO Agri-Portal, Agrowatch Portal, iKissan, etc.along with some mobile based Apps likemKRISHI® Fisheries, riceXpert, Pusa Krishi, Krishikosh, m4agriNEI etc. launched in India are some of the successful digital intervention for technology dissemination.

The use of internet, mobile and video- conferencing assists the IT enabled farmers to utilize the facilities for their favors for which the most suitable permanent infrastructure is the basic requirement. Strong linkages need to be established between direct ICT interventions and it should be part of the national level program on agricultural development.

**g. Disruptive Extension approach:**

Recently, a new extension approach christened as 'disruptive extension' comes into limelight which is considered as an innovative extension approach that creates a new paradigm of extension that eventually disrupts an existing approach followed by extension professionals in the field of agriculture and allied sectors.It is an entrepreneurial oriented sustainable extension system that can able to transform every link in the food chain, from farm to fork.It is a cost-recovery extension approach the fulcrum of which lies between resource exploitation on one side and resource conservation on another side that influence the livelihood security and technology sustainability for small scale farm holders. It deals with the following principles:

- Importance of good governance in agriculture (and allied fields) that considers the resource rights of the farmers.
- Emphasis on growing interest among the stakeholders by explicit analysis of field level issues for technology adoption.
- Potential to resolve the social conflicts for equal access to community resources through Memorandum of Understanding (MOU).
- Based on cost recovery mechanism.

- Ensure commitment to optimum resource management and maximum economic benefit to improve food security.
- Provision of community based social insurance.
- Maintaining the sustenance of the technology supports through custom hiring approach.
- Focus on pluralistic convergence of different partners to build a network of linkage with various entities around the farm households.
- Encouraging the farmers-scientist interaction for technology development, assessment and application through Farmers' FIRST approach.

Global agriculture embraces diverse actors in its endeavour to feed about 10 billion people in the planet by the end of 2050. The small, marginal & landless farmers are extremely vital for food security due to shrinking of resource day by day. The contribution of women farmers also cannot be ignored particularly in on-farm operations, harvesting, post harvest management, processing etc.,especially in fishery and animal husbandry sector.Hence, in today's scenario innovation in agriculture extension is the key to address the growing challenges, which need to be validated, integrated and scaled up and further recommended for large scale implementation by the policy makers. The innovative extension approach should be on capacity building, people's participation along with government initiative to provide strong infrastructure to be worked with the modern age technologies. Much effort has been initiated in going beyond the farm and the farmer, and focus on beyond a technology to the wider innovation system.

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# Chapter 3

## Responsible fishing and its strategic implementation for sustainability

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### Introduction

India is situated north of the equator between 8°4' and 37°6' north latitude and 68°7' and 97°25' east longitude, is the largest peninsular country in the world bordered by Arabian Sea in the west, Indian Ocean in the south and the Bay of Bengal in the east. India has a coastline of 8118 km and 0.5 million sq. km continental shelf endowed with 2.02 million sq. km of Exclusive Economic Zone (EEZ). It has a catchable annual fisheries potential yield of 4.41 million t occupying third rank in world marine fish production (Table 1). India's territorial waters extend into the sea to a distance of 12 nautical miles from the coast baseline. The vital details on marine capture fisheries of India are given in table 1.

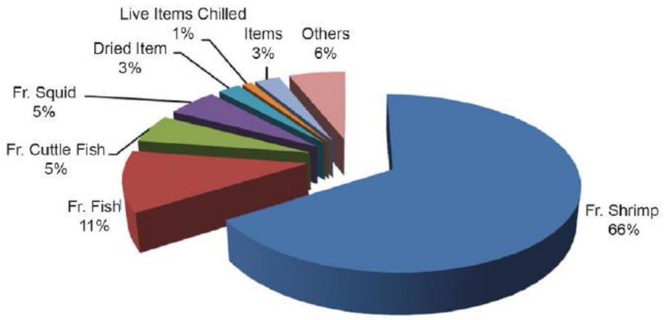
**Table 1. Marine capture fisheries of India**

| | **India** |
|---|---|
| Lengthofcoastline(km) : | 8,118 |
| Continentalshelf(km2) : | 5,30,000 |
| ExclusiveEconomicZone(km2) : | 20,20,00 |
| AnnualpotentialyieldfromEEZ(metrict) : | 4.41 |
| Fishingvillages(No.) : | 3,432 |
| Fishlandingcentres(No.) : | 1,535 |
| Fishermenfamilies(No.) : | 8,74,749 |
| Fisherpopulation(No.) : | 40,56,21 |
| Marinefishingfleet(No.) : | 1,99,141 |
| Mechanisedfishingvessels(No.) : | 72,749 |
| Motorisedfishingvessels(No.) : | 73,410 |
| Non-motorisedfishingvessels(No.) : | 52,982 |
| Fishproduction(2016)(million t) | 3.63 |

Source: GOI (2011a); DADF (2012); CMFRI (2012, 2013a, 2016)

The contribution to foreign exchange earnings by the fishery sector substantially increased from `46 crores in 1960 - 61 to 30,420.83 crores (US$ 4.7 Billion) in 2015-16. Seafood exports from India, during 2015-16, has been 1.05 million t (MPEDA, 2016). USA and South East Asia continued to be the major importers of Indian seafood as in the previous year. Frozen Shrimp was the major export item followed by frozen fish. (MPEDA, 2016).

**Item wise exports 2015-2016 (Value in USD)**




MPEDA (2016)

**Fishery resource potential and production**

Fish production in India has shown an increasing trend during the last six decades. Globally, India ranked second in world total fish production. The total fish production in the country increased twelve fold from 0.74 million t in 1950 to 10.07million t in 2014-2015 (FAO, 2016). India, with its highly productive fishing area has registered 3.63 million t marine fish production during 2015-16. Indian mackerel became the highest contributor with 2.49 lakh tonnes as the declining trend in Indian oil sardine landings continued.

The summary of the potential resources in the different realms and depth zones are given in Table 2 and 3

Table 2. Potential yield for different realms

| **Realm** | **Potential(t)** |
|---|---|
| Pelagic | 2,128,424 |
| Demersal | 2,066,763 |
| Oceanic | 216,500 |
| **Total** | **4,411,687** |

Source: GOI (2011b)

Table 3. Potential yield for different depth zones

| **DepthZone** | **Potential(t)** |
|---|---|
| Upto100m | 3,821,508 |
| 100-200m | 259,039 |
| 200-500m | 114,640 |
| Oceanic | 216,500 |
| **Total** | **4,411,687** |

Source: GOI (2011b)

**Fish harvesting systems**

Fishing gears and practices ranging from small-scale artisanal to large-scale industrial systems are used for fish capture in India. Most important among these are trawls, purse seines, lines, gillnets and trap systems. Some of the traditional gears have also evolved into large and more efficient versions.

The mechanisation of indigenous vessels enabled the fishermen to fish in distant off-shore waters, which were previously inaccessible to them (Chidambaram, 1956). Introduction of small mechanised vessels, motorisation of country vessels, introduction of resource specific vessels and introduction of fishing fleet with state of the art equipment for fish detection and capture were the four development phases (Edwin et al 2014). Synthetic materials have been the mainstay in the production of fisheries gear since the past half century, the main synthetic fibre being used for fishing are Polyamide (PA), Polyethylene (PE), polypropylene (PP) etc.

Now, the entire mechanised fisheries sector uses only synthetic fibers for net making. Twisted netting yarns and braided netting yarns of different sizes are available in the country. Polyamide (PA) monofilament is being extensively used as an import substitute for tuna and shark longlines. The development of combination wire rope for deep-sea fishing is a recent innovation which has now been commercialised. CIFT has standardised specifications for the use of PP multifilament netting yarn with lower specific gravity and better tenacity than nylon.

There are about 1, 99,141 fishing vessels in the sector, of which nearly 72,749 are mechanised vessels (36.5%), 73,410 are motorised (36.9%) and the rest 52,982 non-motorised (26.6%) (Table.4).

Table 4. Fishing vessels in India

| **State/UnionTerritory** | **MechanisedVessels** | **MotorisedVessels** | **Non MotorisedVessels** | **TotalMarine FishingVessels** |
|---|---|---|---|---|
| WestBengal | 14,282 | 0 | 3,066 | 17,348 |
| Odisha | 2,248 | 3,922 | 4,656 | 10,826 |
| Andhra Pradesh | 3,167 | 10,737 | 17,837 | 31,741 |
| TamilNadu | 10,692 | 24,942 | 10,436 | 46,070 |
| Puducherry | 369 | 1,562 | 662 | 2,593 |
| Kerala | 4,722 | 11,175 | 5,884 | 21,781 |
| Karnataka | 3,643 | 7,518 | 2,862 | 14,023 |
| Goa | 1,142 | 1,297 | 227 | 2,666 |
| Maharashtra | 13,016 | 1,563 | 2,783 | 17,362 |
| Gujarat | 18,278 | 8,238 | 1,884 | 28,400 |
| Daman&Diu | 1,000 | 359 | 321 | 1,680 |
| Andaman & Nicobar | 61 | 1491 | 1637 | 3189 |
| LakshadweepIsland | 129 | 606 | 727 | 1462 |
| Total | 72749 | 73,410 | 52,982 | 1,99,141 |

Source: DADF (2012)

Advances in satellite-based technologies such as global positioning system (GPS) have positively influenced the precision in fishing, and Global Maritime Distress Safety System (GMDSS) based rescue system have facilitated safety of fishermen. Satellite remote sensing application in Indian fisheries helped to make maps of Potential Fishing Zones (PFZ), which in turn helped the fishermen to reduce search time and significantly increase catch per unit effort (Solanki et al., 2003).

The increase in fish production over the years has been the result of increased vessel number and capabilities, availability of large and more efficient gear systems, developments in electronic, navigational and acoustic detection equipment which increased the area of operation of the mechanised fishing fleet.

**The FAO Code of Conduct for Responsible Fisheries**

The Code of Conduct for Responsible Fisheries (CCRF) sets out the principles and international standards of behaviour for responsible practices to ensure long term sustainability of living aquatic resources, with due respect for the ecosystem, biodiversity and environment. It covers conservation; management and development of fisheries; capture, processing and trade of fish and fishery products; aquaculture; fisheries research; and integration of fisheries into coastal area management. The key principles of the Code include (i) management of stocks using the best available science; (ii) application of the "precautionary principle," using conservative management approaches when the effects of fishing practices are uncertain; (iii) avoiding overfishing and preventing or eliminating excess fishing capacity; (iv) minimisation of bycatch and discards; (v) prohibition of destructive fishing methods; (v) restoration of depleted fish stocks; (vi) implementation of appropriate national laws, management plans, and means of enforcement; (vii) monitoring the effects of fishing on the ecosystem; (viii) working cooperatively with other states to coordinate management policies and enforcement actions; (ix) recognizing the importance of artisanal and small-scale fisheries, and the value of traditional management practices.

***Article 8 of CCRF: Fishing operations***

Article 8 in the Code of Conduct of Responsible Fisheries is elaborated in *FAO Technical Guidelines for Responsible Fisheries 1: Fishing Operations* (FAO, 1996a). Article 8 contains 11 Sections and 52 sub-sections dealing with the Code of Conduct for Responsible Fishing Operations. The Article 8 include Sections (8.1) Duties of all states, (8.2) Flag State duties, (8.3) Port State duties, (8.4) Fishing operations, (8.5) Fishing gear selectivity, (8.6) Energy optimization, (8.7) Protection of aquatic environment, (8.8) Protection of the atmosphere, 8.9) Harbours and landing places for fishing vessels, (8.10) Abandonment of structures and other materials, and (8.11) Artificial reefs and fish aggregation devices.

Article 8 of the Code of Conduct for Responsible Fisheries which covers Fishing Operations and Article 12 on Fisheries Research have a number of provisions which are of direct relevance to the fishing gear research, design, development and operations. Section 8.4 on Fishing operations, says that states should ensure that fishing is conducted with due regard to the safety of human life relating to the organisation of marine traffic, protection of marine environment and prevention or loss of fishing gear. It also seeks to prohibit destructive fishing practices such as dynamiting and poisoning, it also explains the need to minimise loss of fishing gear and ghost fishing effects of lost and abandoned fishing gear through development of technologies, materials and operational methods; and emphasises the need for environmental impact assessment prior to the introduction of new fishing gear and practices to an area.

Section 8.5 on Fishing gear selectivity focuses on the development and wide spread adoption of fishing gear and methods which would minimise waste, discards, catch of non-target species. The article on Fisheries Research, also seeks to ensure investigations on selectivity of fishing gear, the environmental impact of fishing on target species and behaviour of target and non-target species in relation to fishing gears. (Boopendranath, 2010).

Section 8.6 deals with appropriate standards and guidelines which would lead to the more efficient use of energy in harvesting and post harvesting activities within the fisheries sector and Section 8.7 deals with the pollution and disposal of waste generated during the vessel operation

Section 8.11 seeks to promote the development and use of artificial reef and fish aggregation devices. Responsible fishing technologies have been reviewed by Boopendranath (2009) and Boopendranath and Pravin (2009).

**CIFT's initiatives in Responsible fishing**

**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 mechanised craft, introduction of more specialized crafts, broadening to a full-fledged fishing fleet. 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 fillip 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 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**

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 Rs. 48,000. The boat has wider space, a canopy for protection from rain and sun, low rolling characteristics during fishing, and also has provision of navigational lights to facilitate fishing in the night.

**Fuel efficient multi-purpose fishing vessel**

ICAR-CIFT has been instrumental in introducing designs of commercial, research and multipurpose 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 launched on 18 April, 2016. The hull of this vessel 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 $^0$C to -1 $^0$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.

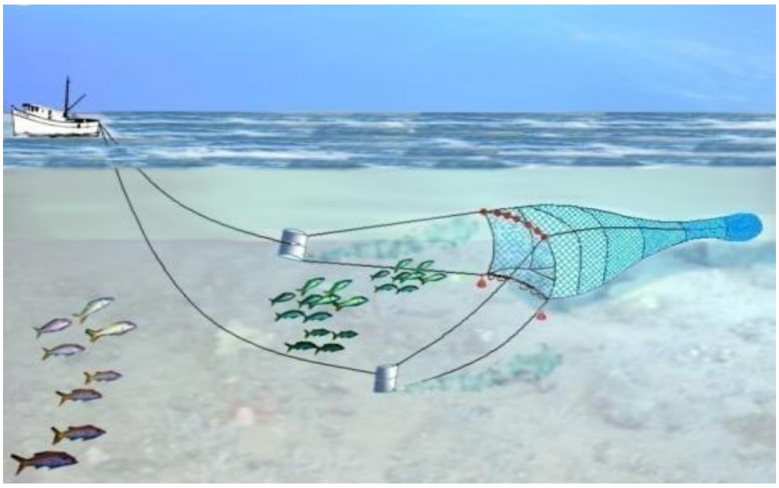
‘Target catch’ is the species or species assemblage primarily sought in a fishery, ‘incidental catch’ is the retained catch of non-targeted species and ‘discarded catch’ is that portion of catch returned to the sea because of economic, legal or personal considerations (Alverson et al., 1994). Bycatch includes both discarded and incidental catch. In addition to the non-targeted finfishes and invertebrates, bycatch also involve threatened and protected species like sea turtles.

**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. CIFT Semi-pelagic Trawl System (CIFT-SPTS) 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 fin fishes and cephalopods, which are mostly beyond the reach of conventional bottom trawls, currently used in commercial trawl fisheries in India.



Eco-friendly off bottom trawl system

**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 CIFT for protecting juveniles and for pre-sorting of the catch (Boopendranath et al., 2008; WWF, 2009).

**Square mesh codend**

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 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 CIFT in the Sindhudurg District of Maharashtra under a UNDP – GEF project. Most recently the Govt. of Kerala has adopted 35 mm square mesh cod end for fish trawl and

25 mm cod end 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. 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, Orissa, Andhra Pradesh, Tamil Nadu and southern parts of Kerala. 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 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, Orissa, 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, Orissa, 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 gill nets may include marine mammals, sea turtles and sea birds, in addition to non-targeted fish species. Optimisation of gill net mesh size and hanging coefficient according to the target species and size group and judicious deployment of gill net in terms of fishing ground, fishing depth and season in order to minimise the gear interaction with the non-targeted species are important bycatch mitigation measures for gill net fisheries. One approach to minimise ghost fishing by lost gill nets, 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. Optimised 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 minimise juvenile catch in traps.

**Green Fishing Concept**

The green fishing concept encompasses energy conservation in fishing and minimising environmental impact of fishing gears in all fisheries.

**Energy conservation in fishing**

Motorised and mechanised 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 in 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 trawler 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; (v) 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, 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 gill nets 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 8 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.

**Minimising environmental impact of fishing gears**

Dragged gears as trawls, particularly when they are heavily rigged, could cause severe damage to benthic fauna and flora, which occupy the bottom substratum and contribute to the productivity of the region. Direct and indirect impacts of bottom trawling on marine environment and benthic communities are well known (Hall, 1999; Kaiser and de Groot, 2000; Barnes and Thomas, 2005; Meenakumari et al., 2009 and others).

**Conclusion**

The implementation of responsible fishing methods starts with the research on design, development and operation of fishing vessel and fishing gear. A country like India has already a wide range of technology for bycatch reduction, minimising environmental impact and energy conservation based on FAO- CCRF. Creating awareness among stakeholders with suitable incentives will result in faster adoption of such technologies. Policy initiatives and amendment of existing legislation will facilitate sustainable fishing in India.

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# Chapter 4

## Value added fish products

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Value addition is the most talked about word in food processing industry, particularly in export oriented fish processing industry because of the increased realization of valuable foreign exchange. Value can be added to fish and fishery products according to the requirements of different markets. These products range from live fish and shellfish to ready to serve convenience products. As far as fish processing industry is concerned value addition is one of the possible approaches to raise profitability since this industry is becoming highly competitive and increasingly expensive.

There is great demand for seafood/seafood based products in ready to eat “convenience” form. A number of such diverse products have already invaded the western markets. One factor responsible for such a situation is more and more women getting educated and taking up employment. Reasonably good expendable income, education, awareness and consciousness towards hygiene and health, increased emphasis on leisure pursuits etc. are some of the other reasons.

Marketing of value added products is completely different from the traditional seafood trade. It is dynamic, sensitive, complex and very expensive. Market surveys, packaging and advertising are a few of the very important areas, which ultimately determine the successful movement of a new product. Most of the market channels currently used is not suitable to trade value added products. A new appropriate channel would be the super market chains which want to procure directly from the source of supply. Appearance, packaging and display are all important factors leading to successful marketing of any new value added product. The retail pack must be clean, crisp and clear and make the contents appear attractive to the consumer. The consumer must be given confidence to experiment with a new product launched in the market. Packaging requirements change with product form, target group, market area, species used and so on. The latest packaging must also keep abreast with the latest technology.

**Chilled fish**

Chilling is an effective way of reducing spoilage by cooling the fish as quickly as possible without freezing. Immediate chilling of fish ensures high quality products. Chilled fish is another important value added item of international trade. Chilled fish fetches more price than frozen fish. It is generally accepted that some tropical fish species can keep for longer periods in comparison to fish from temperate or colder waters. Up to 35% yield of high value products can be expected from fish processed within 5 days of storage in ice, after which a progressive decrease in the utility was observed with increase in storage days. Modern packaging techniques viz., vacuum packaging, modified atmospheric packaging and active packaging significantly enhances the shelf life of chilled fish products.

**Frozen fish fillets**

Freezing and storage of whole fish, gutted fish, fillets etc. are methods for long-term preservation of these species. Many varieties of fresh water fishes like rainbow trout, shell fishes, catla, rohu, tilapia fillets can be frozen for domestic market and export to developed countries in block frozen and IQF forms. In the importing countries these fillets are mainly used for conversion into coated products. Fish fillets can also be used for the production of ready to serve value added products such as fish in sauce and fish salads.

**Speciality products**

*Stretched shrimp (Nobashi)*

Increasing the length of peeled and deveined shrimp and minimising its curling by making parallel cuttings at the bottom and applying pressure using simple mechanical devices is a new technique adopted by the seafood processing industry in recent years. Increasing the length by about 1-2 cms depending on the size of the shrimp is possible by this method. The stretched shrimp will have better appearance compared to conventional PD shrimp and it also fetches higher unit price. The stretched shrimp because of its increased surface area will have more pickup of coating during battering and breading and also good appearance.

Shrimp is washed in chilled water containing 5-ppm chlorine, beheaded, deveined, using bamboo stick and pealed keeping the last segment and tail intact. The tail is then trimmed and the shrimp is stretched using a metallic stretcher after making 2-3 parallel cuttings at the bottom side. Stretched shrimps are then packed in thermoformed trays under vacuum and frozen at -40°C.

*Barbecue*

Shrimp is washed in chilled water containing 5-ppm chlorine, beheaded, deveined, peeled and again washed in chilled water. Bamboo stick is then pierced into the meat from head portion to tail. It is then packed in thermoformed trays under vacuum and frozen at -40°C.

*Sushi (Cooked butterfly shrimp)*

Shrimp is washed in chilled water containing 5ppm chlorine, beheaded, deveined and again washed in chilled water. Bamboo stick is then pierced between the shell and the meat from head portion to tail and then cooked in 1% brine for two minutes at 100°C. The cooked shrimp is then cooled in chilled water, bamboo stick removed and then peeled completely, including the tail fans. The ventral side is then gently cut down lengthwise completely using a sharp scalpel. The cut surface is then gently opened up to form the butterfly shape, packed in thermoformed trays under vacuum and frozen at -40°C.

*Skewered shrimp*

The process is similar to that of barbecue, but piercing is carried out in such a way that 4-5 shrimps are arranged in a skewer in an inverted " U" shape. It is then packed in thermoformed trays under vacuum and frozen at -40°C.

*Shrimp head-on (centre peeled)*

Shrimp is washed in chilled water containing 5 ppm chlorine, pealed at the centre keeping the head and the last two segments intact, deveined, and the tail is trimmed. It is again washed in chilled water packed in thermoformed trays under vacuum and frozen at -40°C.

*Shrimp head-on cooked (centre peeled)*

Shrimp is washed in chilled water containing 5 ppm chlorine, deveined and then cooked in 1% brine for two minutes at 100°C. It is immediately cooled in chilled water and pealed keeping the head and the last two segments intact. The tail is trimmed and again washed in chilled water. It is then packed in thermoformed trays under vacuum and frozen at -40°C.

**Battered and breaded fish products**

Consumers are looking for better alternative for conventional fresh food that offers time-saving preparation. Hence there exists an increased global demand for ready-to-heat frozen foods, especially breaded and battered products with high standards of quality. Battering and breading enhances the consumer satisfaction by improving the nutritional value, organoleptic characteristics and appearance of the products. The most important advantage of coating is value addition as it increases the bulk of the product. Also this paves way for better utilisation of low cost or underutilised fishes. Coating is referred as the batter and/or breading adhering to a food product. Each ingredient in coating offers unique role in development of functionality and characteristics of the product. Polysaccharides, proteins, fat, seasonings and water are the commonly used ingredients. The method of product development differs with the type of product. Mostly this includes seven major steps.

**Portioning / forming**

A perfectly portioned product is the right starting point. Mechanically deboned fish meat is formed to different shapes and sizes after mixing with ingredients, if needed. The product should keep its consistency with proper weight and shape. The key factor in this production step is speed and accuracy of processing the frozen fish block at minimum costs without any compromise to the product quality.

**Predusting**

Predusting is usually done with very fine raw flour type material or dry batter itself, sprinkled on the surface of food substrate before coating. This helps to reduce the moisture on the surface of the product so that the batter can adhere uniformly. Flavourings such as salt and spices can be added in minimum amounts.

**Battering**

Batter is defined as the liquid mixture composed of water, flour, starch, and seasonings into which the fish products are dipped prior to breading. Two types of batter are there- adhesive batter and tempura batter. The adhesive batter is a fluid, consisting of flour and water. Tempura batter is the puff-type batter containing raising/leavening agents. This forms a crisp, continuous, uniform layer over the food. The predusted portions are applied with wet batter and excess batter can be blown off by a current of air. The batter mix helps in governing the amount of bread to be picked up and it contributes to flavour of the final product. Specific ingredients are used to aid viscosity, texture and adhesion.

*Ingredients of batter mix*

a) Flour- Wheat flour provides structure to the product through gelatinisation of starch as well as through formation of gluten protein matrix. Higher protein levels in flour increases viscosity of batter and produce darker crispy coatings. Corn flour can be added to produce yellow colour and to enhance browning during frying.

b) Water- The ratio of water to dry batter mix is 1.8:1. Formation of gelatinised starch phase, hydration of flow proteins, batter viscosity etc. depends on the purity of water used.

c) Starch- Corn starch is added mainly to control batter viscosity and thus increasing the batter pickup and breading retention.

d) Flavour and flavour enhancers- salt, sugar, spices etc. can be added to improve the organoleptic characteristics of the products.

e) Sodium tripolyphosphate- This lowers the water activity of the product and has bactericidal property. It increases the hydration of proteins and reduces protein denaturation.

**Breading**

Breading was defined as the application of a dry mixture of flour starch, seasonings having a coarse composition to battered food products prior to cooking. Normally the battered fish portions are dropped in to dried bread crumbs and are turned over to ensure complete coating with bread crumbs. A fine layer or coarse layer of bread crumps will contribute to structure and tastiness of the product. For soft products the crump depth should be fine so as to avoid the product damage on further processing.

**Pre-frying/ flash frying**

Pre-frying is the process of giving a shallow fry so as to coagulate batter over the product and lock the flavour and juices to the product. The time of frying and temperature of oil are crucial factors. This could be done at 180-200°C for 40-60 sec, thus restricting the actual heat transfer to the surface of the product. The term pre-frying is used as frying will be completed only when the consumers fry the product for 4-6 minutes depending on the product size.

**Freezing**

The fish portions are air cooled before freezing. This helps the coating temperature to drop while the batter can stabilise itself and recover from the frying shock. Freezing is done at a temperature of -10°C to -20°C in order to preserve freshness and quality of the product over longer storage periods.

**Packaging and storage**

Proper packaging and storage is essential to prevent/retard desiccation, discolouration and rancidity in coated products. Packaging in thermoformed containers and storage at -20°C are most commonly used for breaded and battered products. The developments in value added product industry demands the packaging that can withstand the higher temperatures of microwave reheating.

**Advantages of coated products**

- Enhanced nutritional quality
- Moisture barrier during frozen storage and reheating

- Crispy texture and appealing colour and flavour
- Structural reinforcement of the substrate
- Prevents loss of natural juices
- Increased bulk of the substrate and reduced product cost
- Improved overall acceptability of the product

Battering and breading have contributed significantly to the value addition of fishes, shell fishes and molluscs. The first commercially successful coated fish item was fish fingers. Later several other products like fish cutlets, fish balls, fish nuggets, etc. came into the market. Coated butterfly shrimp, squid rings, stuffed squid rings etc. are among the fancy items that cater to the luxury markets. Sophisticated equipments like meat bone separator, meat strainer, portioning and forming equipment, preduster, battering and breading machine, fryer, freezer and packaging machineries are in the market for preparation of a wide variety of coated products.

**Fish finger or Fish portion**

Fish fingers, or portions or sticks are regular sized portions cut from rectangular frozen blocks of fish flesh. They are normally coated with batter, and then crumbed before being flash fried and frozen. They may be packed in retail or catering - size packs. The typical British fish finger normally weighs about 1 oz. (28 g) of which up to about 50% of the total weight may be batter and crumbs. Food Advisory Committee of the UK government has recommended a minimum fish content of 55% for battered and 60% for the fingers coated with breadcrumbs.

**Shrimp products**

Battered and breaded shrimp can be prepared from wild as well as from farmed shrimp in different styles and forms. The most important among them are butterfly, round tail-on, peeled and deveined (PD), nobashi (stretched shrimp) etc. The products from farmed shrimp have indicated longer shelf life, 16-18 months compared to those from wild variety 12-14 months at –20 ºC

**Fish fillets**

The brined fillets are battered and breaded. Fillets from freshwater fish are also used for the production of coated products. The only problem noticed in this case is the presence of fin bones; its complete removal is still a major hurdle.

**Squid products**

Squid rings and stuffed squid are the popular coated products processed out of squid. Cleaned squid tubes are cut in the form of rings of uniform size, cooked in boiling brine (3%) for 1-2 minutes followed by cooling, breading and battering. The coated rings are flash-fried, cooled, frozen and packed. Stuffed squid is generally processed out of small size animals. The cleaned tubes are filled with a stuffing mixture prepared using cooked squid tentacles, potato, fried onion, spices etc. It is then battered, breaded and flash-fried.

**Clam and other related products**

Meat shucked out from depurated live clams after boiling is blanched in boiling brine, cooled, battered, breaded, flash-fried and packed. Other bivalves such as oyster, mussels etc. can also be converted into coated products by the same method.

**Fish cutlet**

Cooked fish mince is mixed with cooked potato, fried onion, spices and other optional ingredients. This mass is then formed into the desired shape, each weighing approximately 30g. The formed cutlets are battered and breaded.

**Fish balls**

Fish balls are generally prepared from mince of low cost fish. Balls can be prepared by different ways. The simplest method is by mixing the fish mince with starch, salt and spices. This mix is then made into balls, cooked in boiling 1 % brine. The cooked balls are then battered and breaded.

**Crab claw balls**

Swimming legs of crab may be used for this purpose. Crab claws are severed from the body, washed in chilled portable water and the shell removed using a cracker. The leg meat is then removed and mixed with 2 % starch based binder. This is then stuffed on the exposed end of the claw. Alternatively the body meat mixed with the binder also can be used for stuffing. The stuffed claw is then frozen, battered and breaded and flash fried. The coated products are packed in thermoformed containers with built in cavities.

**Mince based products**

Fish mince separated from skin, bone and fins are comminuted and used for preparation of different products. Battered and breaded products like fish fingers, fish balls, cutlet etc. are produced. Fish cultlets fetch good demand in domestic markets while fish fingers are demanded in export market. Fish cutlets with partial replacement of fish meat with soy protein will increase the acceptability and storage stability of fish cutlets. A ready to eat novel battered and breaded snack product, 'Oyster pablano pepper fritter' have a good scope of attraction in value added markets. Fish finger from Bombay duck adds on to the value addition potential of fish in our markets. Fish rolls with good shelf life can be developed from frame meat of fishes, eg: rohu. Fish sausage, cakes and patties are some other mince based products.

**Surimi and surimi based products**

Surimi, term for the mince that are deboned and washed, also act as an intermediary in development of various products. It is one among the most consumed product fish. Low cost fishes can be conveniently used for the preparation of surimi. Block frozen surimi and surimi based products are popular. Shell fish analogue products from surimi fetches good demand in both domestic and export markets. The history of surimi in India starts in1990’s with the first surimi manufacturing plant was set up in 1994. The Indian company ‘Gadre Marine’ became the third largest manufacturer of surimi, exporting to 24 countries over the world. This shows the potential for production of surimi and surimi based products in India. The demand of these products are less in domestic markets but is expanding nowadays. These healthy and simple products have great scope in indian markets as people are moving towards different alternatives. Shell fish analogue products from surimi fetches good demand in both domestic and export markets.

**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. These products have a shelf life of more than one year at room temperature. As there is increasing demand in National and International market for ready to serve products the retort pouch technology will have a good future. The technology for retort pouch processing of several varieties of ready to serve fish and fish products has been standardised at CIFT and this technology has been transferred successfully to entrepreneurs.

**Extruded products**

Fish based extruded products have got very good marketing potential. Formulation of appropriate types of products using fish mince, starches etc., attractive packaging for the products and market studies are needed for the popularization of such products. However, technological studies involving use of indigenously available starches like cassava starch, potato starch, cornstarch and the associated problems need thorough investigation. Such products can command very high market potential particularly among the urban elites. The technology can be employed for profitable utilization of bycatch and low value fish besides providing ample generation of employment opportunities.

**Intermediate moisture products (IMF)**

The IMF technology is based on the reduction in water-activity of food to a level in which most bacteria in will no longer grow. Intermediate moisture product from fishes can be made from a combination of different techniques like drying, pH modification etc.

**Seaweed products/Seaweed incorporated products**

Seaweed incorporation in fish products increases the fibre content and retention of PUFA. 'Nutradrink' and fish soup enriched with seaweed bioactive compounds are novel products developed by CIFT. Sulphated polysaccharides with bioactive properties can be extracted from seaweed. Seaweed incorporated semi-sweet biscuits and extruded snack products will also have good nutrirional importance.

**Fish caviar substitutes**

Polyunsaturated fatty acids and amino acids gives the nutritional importance of fish roe. Besides the commercially available roe from sturgeon, salmon and cod, fish caviar substitute from fresh water carp roe reconstituted with sodium alginate will have a greater potential as value added fish caviar substitute.

**Curing**

The traditional methods of processing fish by salting, drying, smoking and pickling are collectively known as curing. Cured fish consumption is more in areas where the availability of fresh fish is comparatively limited, namely interior markets and hilly areas. This is also the cheapest method of preservation, since no expensive technology is used. In India roughly 20 % of the fish caught is preserved by curing. Considerable quantities of cured fish are also exported, mainly to Singapore, Sri Lanka and to the Middle East. Simple sun drying was the widely practised traditional method of fish preservation. By this, preservation was achieved by lowering of water content in the fish, thereby retarding the activity of bacteria and fungi. The heat was able to destroy the bacteria to a certain extent. Later on, a combination of salting and drying or salting, smoking and then drying were developed.

**Methods of Drying**

There are basically two methods of drying fish. The common one is by utilizing the atmospheric conditions like temperature, humidity and airflow. This is traditional sun drying. The other is dehydration or artificial drying, by using artificial means like mechanical driers for removal of moisture from the fish under controlled conditions.

Sun drying depends heavily on the natural weather conditions since the fish is dried by heat from the sun and the air current carries the water away. Here there is no control over the operations and many a time the losses cannot be substantiated. Hence it is necessary that the operations be controlled to get a product, which has an extended shelf life, but at the same time the texture, taste and flavour is maintained. It is here that artificial driers where processing parameters are controlled gain a lot of importance. Such processes are carried out in a controlled chamber or area. Such products have advantages over sun-dried products since they have better keeping quality and longer shelf life.

In mechanical driers, removal of water from the fish is achieved by an external input of thermal energy. This is an expensive method since there is need for fuel for heating and maintenance of the temperature. The drying chamber consists of a long tunnel in which the washed and cleaned fish is placed on trays or racks. A blast of hot air is passed over the material to be dried. After the required degree of drying the product is removed from drier and packed.

**Salting**

This is one of the oldest methods of preservation of fish. Salting is usually done as such or in combination with drying or as a pretreatment to smoking. During salting osmotic transfer of water out of the fish and salt into the fish takes place, which effect fish preservation. It is based on different factors like diffusion and biochemical changes in various constituents of the fish. Salting amounts to a process of salt penetration into the fish flesh. Penetration ends when the salt concentration of the fish equals that of the surrounding medium. Loss of water during salting limits bacterial growth and enzyme activity, thus preserving the fish. The high salt content prevents the growth of normal spoilage microflora in the fish; but halophiles, which can survive 12-15% of salt, will survive.

**Preparation of some popular products**

**Pickled products**

Fish pickle makes use of the non-fatty variety of low cost fish having good meat content. Major ingredients are: fish, garlic, green chilly, ginger, chilly powder, turmeric powder, gingelly oil/ ground nut, salt, vinegar and sugar. The method of preparation of pickle is simple, the preservative being oil, salt and vinegar. The traditional packing is in glass bottles. Modern packing materials suitable for packing fish pickles have also been identified. Pouches and stand packs made of 12 micron polyester laminated with 118 micron LD/HD co-extruded film can be used for packing pickles.

| Ingredients | Quantity |
|---|---|
| Fish (dressed and cut into small pieces) | 1 kg |
| Mustard (shell removed)-Optional | 10 |

| | |
|---|---|
| | g |
| Green chilly | 50 g |
| Garlic | 200 g |
| Ginger | 150 g |
| Chilli powder | 50 g |
| Turmeric powder | 2 g |
| Gingelly oil/ ground nut | 200 g |
| Vinegar | 400 ml |
| Salt | 60 g |
| Sugar (optional) | 10 g |
| Cardamom, clove & cinnamon (optional) | 1.5 g |

**Process**

Mix the dressed fish with salt at the rate of 3% by weight of fish and dry in the sun /dryer for 2 to 3 hours and then deep fry the fish in oil and keep apart. Then fry mustard, green chilli, ginger and garlic in oil. When frying is adequate add turmeric powder, followed by chilli powder under a low flame and immediately remove from the flame and mixed with fried fish and allowed to cool. Vinegar and salt were added and mixed thoroughly and adjust to a slightly salty taste. Finally sugar was added and mixed thoroughly. Stored the pickle in a clean container for at least 2 overnights for maturing and fill in glass bottles or acid resistant packets (12 µ polyester with 250 gauge LDHD polythene co-extruded film pouches)

*Fish Soup Powder*

Fish soup powder can be formulated from any type of fish having very low fat content. Soup powder prepared from different food materials like vegetables, meat, egg are in use in different parts of the world. These are dry products rich in dietary constituents like protein and minerals. The soup powder prepared out of miscellaneous fish is also a rich source of animal protein and other nutritional factors.

*Ingredients used for the preparation of fish soup powder*

| **Ingredients** | **Qty** |
|---|---|
| Cooked fish meat | 750 g |
| Salt | 170 g |
| Fat | 120 g |
| Onion | 750 g |
| Coriander | 12 g |
| Tapioca starch | 250 g |
| Milk powder | 100 g |

| | |
|---|---|
| Sugar/glucose | 30 g |
| Pepper powder | 15 g |
| Ascorbic acid | 1.5 g |
| Carboxy methyl cellulose | 3 g |
| Monosodium glutamate | 5 g |

**Method of preparation**

Minced fish can be conveniently used for the preparation of soup powder. If whole fish is using it has to be cooked first and the meat is separated from the bones and skin. Cooked pressed meat is the basic raw material for the preparation. Fry the onion till it becomes light brown. Grind the cooked fish, fried onion and other ingredients in a wet food grinder till it becomes a fine paste. Spread the paste in aluminum trays lined with polyethylene sheet and dried in an electrical drier at 50ºC to reduce the moisture content to 8%. Dried material is then pulverized in a mechanical pulveriser. Milk powder is added and packed in airtight containers or laminated polyethylene bags. It has a shelf life of about 8 months at ambient temperature.

*Preparation of soup*

One-teaspoon full (5 g) of powder is made into a paste with 10 ml cold water. This is added to 90 ml boiling water. Continue boiling for 2 minutes. The soup is ready for use.

**Fish flakes or wafers**

Fish wafers are partially deodourized thin flakes of cooked fish meat homogenized with starch and salt. On frying the wafers swell to two to three times of its initial size and become crisp and delicious. It is an ideal snack. Fish mince and starch are the base material for the preparation of wafers

Ingredients used for the preparation of fish flakes

| **Ingredients** | **Qty** |
|---|---|
| Cooked fish meat | 2 kg |
| Refined tapioca starch | 2 kg |
| Corn starch | 1 kg |
| Common salt | 5% |
| Water | 3.5 l |

Process

The cooked fish meat is homogenized in a wet food grinder. Starch, salt and water are added and continued grinding till they become a fine paste. Small portions of the homogenized mass is poured on to flat aluminum trays and spread to a film of 1 to 2 mm thickness. The material is cooked in a steam chamber for 2 to 3 minutes to gelatinise the starch. After this the film become firm and it can be cut into desired shapes. The gelatinized flakes are dried in an electrical drier at 45-50ºC or it can be sun dried. Fry in edible oil and serve hot

**Fish paste**

Fish paste is a high value convenience food popular in South East Asia prepared by mixing fish and salt and allowing it to ferment. This results in the formation of either a paste or a liquid, which is separated from the residue and is used as a flavoring agent Fish paste can also be prepared with out fermentation. Frozen fish paste is not relished because during storage, texture and spreadability are adversely affected.

Fish paste is prepared by finely grinding texturised cooked fish meat, gelatinized, starch, sugar, milk powder, colouring matter and flavour (Table 5). It was packed in flexible pouches made of co-extruded polypropylene, heat processed in air steam pressure in an autoclave and stored at ambient temperature. The shelf life is 36 weeks. It become unacceptable due to changes in texture and spread ability. The proximate composition of fish paste is given in Table 6.

Recipe of fish paste

| **Ingredients** | **%** |
|---|---|
| Fish mince | 78 |
| Fat | 8 |
| Starch | 8 |
| Sugar | 2.25 |
| Milk powder | 2.50 |
| Salt | 1.25 |
| Poly phosphate | 0.50 |

Microbiological studies showed that the product is bacteriologically safe for human consumption. Studies showed that the fish paste is acceptable as bread spread or similar types of products. The large quantity of low value fish with low fat and white flesh available in India can be used for making good quality fish paste.

Fish Noodles

This is a product similar to ordinary noodles available in the market, but contains 21% protein. Surimi is used as the base for the production of fish noodles Table 7). Cooked surimi is kneaded with salt and maida. The mix is passed through the extruder. Gelatinised noodles is dried under sun or in an electrical drier at 50ºC to a moisture level of 8%. The dried noodle is packed in airtight containers or polythene bags. The product has very good rehydration property.

Ingredients used for the preparation of fish noodles

| **Ingredients** | **Qty** |
|---|---|
| Cooked fish mince | 800 g |
| Maida | 1200 g |
| Salt | 60 g |
| Water | 1-2% |

Just like the noodles available in the market only two minutes cooking is required for the preparation of fish noodles.

# Chapter 5

## Nutraceuticals from Fish and Fish Wastes: Scopes and Innovations

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Bio-active compounds having health beneficial effect on human beingsfrom terrestrial and marine sources are considered as “Nutraceuticals”. Nutraceuticals from marine origin are proved to have wide range of therapeutic effects*viz.*,anti-obesity, immune enhancement, natural antioxidant, cardio protective, anti-diabetic, anti-inflammatory effects.These natural products do not have any side effects contradictory to many medicines available today, hence have attracted global market. Microencapsulation technique has been considered as one of the unique methods to encapsulate the bio-active compounds for target delivery. Importance and application of nutraceuticals from marine origin are highlighted.

**Introduction**

World over in the recent past, research in nutraceuticals has shown continuous growth and the progressive approach is aimed at identifying the potential nutraceutical compounds which are having health benefits in human beings. Awareness among the people is the prime reason for the growing demandfor nutraceuticals.Today people are more aware about the nutrition and related health problems. Recently, researchers across the globe are exploring the possibilities to extract and isolate bio-active compounds from both terrestrial and marine sources.

Nutraceuticalis a combination of two words, “nutrition” and “pharmaceutical,” and the word nutraceutical was coined by Stephen L. DeFelice in 1989 (Wildman *et al*., 2006). Nutraceuticals are food products of natural origin from both terrestrial and marine sources having healthcare importance. The word nutraceuticals comprise of variety of products derived from terrestrial and marine sources (isolated nutrients, dietary supplements, and genetically engineereddesigner foods, herbal products, processed foods, andBeverages). Recent report says that nutraceuticals provides a positive healthcare approach with tremendous therapeutic impacts on human body (Das *et al*., 2012; Bagchi*et al*., 2015). A wide range of phytochemicals described as phytoestrogens, terpenoids, limonoids, glucosinolatesphytosterols, polyphenols, carotenoids, flavonoids, isoflavonoids, and anthocyanidins having therapeutic effects on human health as antioxidants, anti-inflammatory, antibacterial, anti-allergic, etc. are identified (Gupta and Prakash, 2014; Karwande and Borade, 2015).

**Classification of Nutraceuticals**

Based on the bio-functional properties of bioactive compounds from terrestrial and marine sources are classified into following –

1. Dietary Supplements
2. Functional foods
3. Medicinal food

## Dietary Supplements

According to the Dietary Supplement Health and Education Act (DSHEA), 1994 in USA, dietary supplements are defined as products comprised of "dietary constituents" and orally administered to supplement the nutritional requirement of diet. The "Dietary constituents" refers to bioactive components comprising of amino acids, vitamins, minerals, fibres, important metabolites, and certain enzymes. The dietary supplements also include extracts available in tablets, capsules, powders, liquids, and in any other dosage form (Radhika *et al*., 2011).

## Functional Food

Functional foods are foods derived from natural origin enriched in nutrients and are being fortified with essential nutrients (Jones, 2002). As per the Health Canada, functional food defines a regular food with an ingredient having specific therapeutic effect along with nutritional value (Wildman *et al*., 2006). Whereas in Japan, functional foods are assessed on the basis of three important standards: (1) functional foods must be derived from natural sources and consumed in their native state instead of processed in different dosage forms like tablet, capsule, or powder; (2) consumed regularly as a part of daily diet; and (3) exert a dual role in prevention and management of disease and contribute in biological processes (Arai, 1996).

## Medicinal food

Medical foods are foods that are specially formulated to be consumed internally under the supervision of a physician, which is intended for the dietary management of particular disease that has distinctive nutritional needs that cannot be met by normal diet alone. Dietary supplements and functional foods do not meet these criteria and are not classified as medical food (Radhika *et al*., 2011).

## Nutraceuticals from marine sources

### Chitin and chitosan

Chitin,a cationic amino polysaccharide,is a natural biopolymer composed of *N*-acetyl-d-glucosamine with β (1 → 4) glycosidic linkages. The term chitosan is used when nitrogen content of chitin is more than 7% by weight or the degree of deacetylation is more than 60% (Peter *et al.*, 1986; Gagne and Simpson 1993). Chitosan is a biopolymer and it consists of d-glucosamine units obtained during the deacetylation of chitin by adopting hot alkali treatment. Chitin and chitosan can be obtained from the bio-waste generated from both terrestrial and marine sources. Chitin is abundant in the marine organisms like lobster, crab, krill, cuttlefish, shrimp, and prawn. The extraction of chitin form marine source comprises of thee-steps: deproteinization (DP), demineralization (DM), and decolorization (DC). Further, chitin has to undergo a de-acetylation process to obtain chitosan. Chitin is known for its unique properties like, biodegradability, nontoxicity, physiological inertness, antibacterial properties, hydrophilicity, gel-forming properties (Se-Kwon, 2010). In India, a few entrepreneurs are producing chitin and chitosan on a commercial scale under the technical guidance of the ICAR-Central Institute of Fisheries Technology, Cochin. In-line with chitin, chitosan also finds extensive application in multidimensional sectors, such as in food and nutrition, biotechnology, material science, drugs and pharmaceuticals, agriculture and environmental protection, dental and surgical appliances,removal of toxic heavy metals, wine clarification, industrial effluent treatment, etc. (Se-Kwon, 2010).

**Glucosamine Hydrochloride**

Generally, glucosamine is obtained from the crustacean waste (Xu and Wang, 2004; Tahami, 1994). Glucosamine is part of the structural polysaccharides such as chitosan and chitin, which is present in the exoskeletons of crustacean and other arthropods. Though, glucosamine was discovered long back, market for glucosamine has gained popular interest due toits health benefits. Dietary supplementation of glucosamine (glucosamine sulphate, glucosamine hydrochloride, or N-acetyl-glucosamine) is proven to promising biomolecule for the treatment of osteoarthritis, knee pain, and back pain (Houpt*et al*., 1999; Luo *et al*., 2005). It is also known for its unique properties like anti-cancer, anti-inflammatory and antibacterial effects (Nagaoka *et al*., 2011).

**Chondroitin sulphate**

Chondroitin sulphate (CS) consists of repeated disaccharide units of glucuronic acid (GlcA) and *N*-acetylgalactosamine (GalNAc) linked by β-(1→3) glycosidic bonds and sulfated in different carbon positions (CS no-sulfated is CS-O). Shark cartilage is found to be a good source of chondroitin sulpahte. Chondroitin sulfate plays various roles in biological processes such as the function and elasticity of the articular cartilage, hemostasis, inflammation, cell development, cell adhesion, proliferation and differentiation by being an essential element of extracellular matrix of connective tissues (Schiraldi*et al*., 2010).

**Hyaluronic acid (HA)**

HA can be obtained from the bio-waste like fish eyeball and it is also present in the cartilage matrix of fishes. HA finds several biomedical applications *viz.*viscosupplementation in osteoarthritis treatment, as aid in eye surgery and wound regeneration. Further, hyaluronic acid finds its applications in drug delivery, tissue engineering applications, gene delivery applications, targeted drug delivery, tumor treatment, environmental applications and sensors (Mathew *et al*., 2017).

**Collagen, gelatin and collagen peptides**

Fish skin and scales which constitutes about 30% and 5% of the total seafood processing discards respectively are considered as the richest source for collagen and gelatin. Collagen derived from marine sources is finding wide applications in various sectors due to its biocompatibility, biodegradability, high cell adhesion properties and weak antigenicity (Yamada *et al*., 2014). Another major application of collagen is to act as a source for extraction of collagen hydrolysates, peptides, gelatin and gelatin peptides. Collagen peptides are reported to have bioactive properties like antioxidant, antimicrobial, antihypertensive, metal chelating, tyrosinase inhibitory, immunomodulatory, neuroprotective, antifreeze, wound healing, cell-proliferation, activities (Zhuang *et al*., 2009; Chi *et al*., 2014).

Gelatin, the denatured form of collagen, by virtue of its surface active properties finds extensive applications in food, pharmaceutical and biomedical industries. Gelatin peptides are reported to have antihypertensive, antioxidant properties. The major difference between fish and mammalian gelatin lies in the iminoacid composition, viz, proline and hydroxyprolinecontents. (Mathew *et al*., 2017).

**Fish lipids**

Across the globe the researchers have well documented the health beneficial effects of long chain omega-3 polyunsaturated fatty acids (PUFA) (Connor, 2000). The major omega-3 PUFA, such as eicosapentaenoic acid (EPA C20:5) and docosahexaenoic acid (DHA C22:6) are very much essential for human beings, and hence are considered as essential fatty acids. The intake of long chain omega-3 PUFA is promoted by many health organizations owing to the health benefits associated with it. An average intake of 0.2 g and 0.65g of EPA and DHA a day is recommended by the European Academy of Nutritional Sciences (EANS) and International Society for the Study of Fatty Acids and Lipids (ISSFAL) respectively (Dedeckere, *et al*., 1998). Fish oil remains as an excellent and economical source of omega-3 PUFA. Having high contents of fat soluble vitamins and lipids, especially EPA, cod liver has been exploited as an omega-3 PUFA source for development of nutraceuticals (Mondello*et al*., 2006). Dietary consumption of fish oil (omega-3 PUFA) in adequate quantities is reported to have health benefits in the treatment of cardiovascular diseases, cancer, hypertension, Alzheimer’s disease, diabetes, arthritis, autoimmune disorders and to improve overall functioning of brain and retina (Cole *et al*., 2009).

**Squalene**

Squalene, a naturally occurring triterpenoid compound, is an intermediate in cholesterol synthesis. It is widely present in nature, such as wheat germ, rice bran, shark liver and olive oils and among all the sources identified, shark liver oil is considered to be the richest source accounting for about 40% of its weight. Recently, the squalene has gained attention due to its diverse bioactivities such as antioxidant, anti-lipidemic, membrane stabilizing, cardioprotective, chemopreventive, anti-cancerous, antiaging properties etc (Passi*et al*., 2002; Ko*et al*., 2002). Further, it is also reported to protect human skin surface from oxidation (Kabuto *et al*., 2013). Based on its diverse bio-active properties, squalene finds applications in field of biomedical, cosmetic, drug delivery systems and even in food industries.

**Minerals**

Marine organisms especially fish are considered as important source of minerals such as sodium, potassium, calcium, phosphorous and magnesium. Fish bone which is often discarded after the removal of protein is an excellent source of calcium and hydroxy apatite. Being rich in minerals, fish bone powder can be fortified into several food products. However, for fortification, the fish bone should be converted into an edible form by softening its structure by pre-treatment with hot water or hot acetic acid or superheated steam. Calcium powder processed from the backbone of tuna is a potential nutraceutical. It can be used to combat calcium deficiency in children. Fortification of calcium in foods helps consumers in meeting the calcium requirements and may reduce the risk of osteoporosis. Other than fish bone calcium, certain other minerals such as selenium, potassium, iodine, zinc, magnesium are more abundant in seafood than in meat. The higher intake of seafood diet will also ensure that adequate amount of iodine is obtained.

**Nutraceutical industry in India: Current scenario and future trends**

During the year 2015, global nutraceutical industry, valued at US$ 182.6 billion and is one of the fastest growing industries today and expected to grow at a Compound Annual Growth Rate (CAGR) of 7.3% from 2015 to 2021. As on today, the United States, Europe and Japan account for about 93% of the total global nutraceutical market and seems to have attained maturity in all three major regions. Hence, nutraceutical industries across the world are now showing their interest to emerging markets like India and China. Nutraceuticals industry in India is one of the rapid growing markets in the Asia-Pacific region. As per the record, the nutraceuticals industry in India is worth about US$ 2.2 billion and is expected to grow at 20% to US$ 6.1 billion by 2019-2020.

**Innovative work done at Central Institute of Fisheries Technology, Cochin**

By adopting grafting and micro-encapsulation technology, ICAR-Central Institute of Fisheries Technology, Cochin has developed some of the nutraceuticals products, such as thiamine and pyridoxine-loaded vanillic acid-grafted chitosan microspheres; sardine oil loaded vanillic acid grafted chitosan microparticles; microencapsulated squalene powder; vanillic acid and coumaric acid grafted chitosan derivatives; thiamine and pyridoxine loaded ferulic acid-grafted chitosan. These nutraceuticals products were shown to have health beneficial and immunomodulatory response in animal models.

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## Chapter 6

**Engineering tools and technologies for fish processing:**
**A profitable venture in agri-business**

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Fisheries comprise a major economic activity within complex interactions between human beings and water - 'the first among equals' of the natural resources (Ahmed, 1992). Fisheries data assembled by the Food and Agriculture Organization (FAO) suggest that global marine fisheries catches increased to 86 million tonnes in 1996, then slightly declined. In the past three decades, employment in *fisheries* and *aquaculture* has grown at a higher rate than the growth of *world* population. The fishery engineering is evolving as an important domain in view of depleting stocks on both pre and post-harvest scenarios. It will also aid in fish processing technologies, optimizing energy and water use in seafood industries, mitigating climate change related issues and reducing carbon foot print. It is important to explore novel ways to obtain, quantify, and integrate industry responses to declining fishing stocks and increasing management regulations into fishery- and ecosystem-based management advice. The technological interventions help to reduce the wastage of fishes, which is otherwise a highly perishable commodity by preservation technologies and converting it into value added products with higher shelf life. Use of appropriate technologies along the fish value chain will help in producing better quality products and fetch more markets and higher price.

Major areas of technological interventions in the field of fishery engineering cover design and development of fish processing equipment and machineries, energy efficient and eco-friendly solar fish dryers, fuel efficient fishing vessels and fiberglass canoes, indigenous electronic instruments for application in harvest and post-harvest technology of fish, quality improvement of Indian fishing fleet and energy and water optimization techniques for fish processing industries. Focused areas include development of cost effective solar dryers with LPG, biomass, Infra-Red or electrical back-up heating systems, fish de-scaling machines, Fish freshness sensor etc.

1.**Technologies for fish processing and value addition**

Post-harvesting processing of fishes are important to reduce the wastage, increase shelf-life, add more value to the products and ensure higher returns. The major engineering interventions for fish post-harvest operations, processing and value addition are given below:

**1.1 Solar dryers:**

Out of total catch 30-40 % of fish is dried or processed for export and local consumption. Sun drying (open air drying) is the traditional method employed in most parts of the state to dry fishery products. It denotes the exposure of a commodity to direct solar radiation and the convective power of the natural wind. This form of energy is free, renewable and abundant in any part of the world especially in tropical countries. Also it offers a cheap method of drying but often results in inferior quality of product due to its dependence of weather conditions and vulnerability to the attack of dust, dirts, rains, insects, pests, and microorganisms. Solar drying is an alternative which offers numerous advantages over the traditional method and environmentally friendly and economically viable in the developing countries. In solar drying, a structure, often of very simple construction, is used to enhance the effect of the solar radiation. Compared to the sun drying, solar dryers can generate higher air temperatures and consequential lower relative humidity, which are conducive to improved drying rates and lower final moisture content of the final products. However, there exist some problems associated with solar drying i.e. reliability of solar radiation during rainy period or cloudy days and its unavailability during night time. To overcome this limitation, an auxiliary heat source and forced convection system are recommended for assuring reliability and better control, respectively.

In a hybrid solar drying system, drying can be continued during off-sunshine hours by utilizing back up heat source and stored heat energy of daytime sunshine. In this way, drying becomes continuous process and the product is saved from possible deterioration by microbial infestation. These types of Hybrid solar dryers find useful applications in developing countries where the conventional energy sources are either scarce or expensive and the heat generating capacity of the solar system alone is not sufficient. Further, to assist the drying process (forced convection) in a hybrid dryer, a small blower is attached in between solar collector and drying chamber or inside the drying chamber which is powered by solar PV panels installed on drying chamber. Moreover, power from PV panels can be used for street lighting purpose. In addition, if the proposed setup is not used for drying purpose (kept idle), then the same can be used to draw hot water for domestic use. Therefore, in a single set up it is envisaged to have multiple utilities i.e. drying of fish, hot water and electricity generation.

Design of solar dryer varies from simple direct dryers to more complex hybrid designs. Hybrid model solar dryers are having LPG, biogas, biomass or electricity as alternate back up heating source for continuous hygienic drying of fish even under unfavourable weather conditions. ICAR-CIFT has developed different models and capacities of solar dryers for hygienic drying of fish. The capacity of these hybrid solar dryers varies from 6 to 110 $m^2$ of tray spreading area for drying of various quantities of fish varying from 10 kg to 500 kg.

The labour requirement is considerably reduced compared to open sun drying in beaches / coir mats because of the elimination of cleaning process due to sand and dust contamination. Re-handling process like spreading, sorting and storing because of non-drying or partial drying due to unfavourable weather conditions and spoilage due to rain is also not required. The drying time is reduced considerably with improved product quality. Improved shelf life and value addition of the product fetches higher income for the fisher folk. The eco-friendly solar drying system reduces fuel consumption and can have a significant impact in energy conservation.

ICAR-CIFT design includes small capacity dryers like solar tent dryers, natural convection dryers *etc.* which will be useful to dry fish hygienically during sunny days. Solar tunnel dryers, solar fish dryers with alternate electrical back up (SDE-10, SDE-20 and SDE-50) and solar fish dryers with fire wood or biomass alternate back up heating system (SDF-20, SDF-50) *etc*. can be efficiently used to dry fish using renewable solar energy which is abundantly and freely available. The details of solar dryers with different backup systems are given below:

**(a) Solar Dryer with LPG back-up:**

ICAR-CIFT designed and developed a novel system for drying of fish using solar energy supported by environment friendly LPG back up (Fig.1). In this dryer during sunny days fish will be dried using solar energy and when solar radiation is not sufficient during cloudy/ rainy days, LPG back up heating system will be automatically actuated to supplement the heat requirement. In the solar fish drier with LPG back up heating system, water is heated with the help of solar vacuum tube collectors installed on the roof of the dryer and circulated through heat exchangers provided in the PUF insulated stainless steel drying chamber loaded with fish. Thus continuous drying is possible in this system without spoilage of the highly perishable commodity to obtain a good quality dried product.

This dryer is ideal for drying of fish, fruits, vegetables, spices and agro products without changing its colour and flavour. It helps to dry the products faster than open drying in the sun, by keeping the physico-chemical qualities like colour, taste and aroma of the dried food intact and with higher conservation of nutritional value. Programmable logical Controller (PLC) system can be incorporated for automatic control of temperature, humidity and drying time. Solar drying reduces fuel consumption and can have a significant impact in energy conservation.

Fig.1. CIFT Solar-LPG Dryer

**(b) Solar dryer with Electrical back-up:**

Effective solar drying can be achieved by harnessing solar energy by specially designed solar air heating panels and proper circulation of the hot air across the SS trays loaded with fish (Fig.2). Food grade stainless steel is used for the fabrication of chamber and perforated trays which enable drying of fish in a hygienic manner. Since the drying chamber is closed, there is less chance of material spoilage by external factors. An alternate electrical back-up heating system under controlled temperature conditions enables the drying to continue even under unfavourable weather conditions like rain, cloud, non-sunny days and in night hours, so that the bacterial spoilage due to partial drying will not occur. Improved shelf life and value addition of the product fetches higher income for the fisher folk. The eco-friendly solar drying system reduces fuel consumption and can have a significant impact in energy conservation.


Fig.2 CIFT Solar-Electric Dryer

(c) **Solar-Biomass Hybrid dryer**: A dryer working completely on renewable energy was designed and developed for eco- friendly operation. Solar Biomass Hybrid Dryer consists of well insulated and efficient solar air-heating panels, drying chamber, SS mesh trays, photo-voltaic cells, fans and biomass heating system (Fig.3). Hot air is generated by virtue of solar energy inside the heating panels and passed into the drying chamber. Continuous flow of hot air is maintained with the help of Photo Voltaic cells and fans to enable drying process. During cloudy days when sufficient solar energy is not available to maintain required temperature within the dryer, an alternate biomass heating system is manually actuated. Thus a fully green technology for fish drying is achieved by this.

Fig.3 CIFT Solar-Biomass Dryer

**(d) Solar Tunnel dryer:** Solar tunnel dryer utilizes solar energy as the only source of heat for drying of the products. Heat absorbing area of 8 $m^2$ is made of polycarbonate sheet (Fig.4) . Products to be dried are placed on nylon trays of dimension 0.8X0.4 m. The dimensions of the whole drying unit is 2.21X2.10X0.60 m. The capacity of the dryer is 5 kg. Drying takes place by convection of hot air within the drying chamber. Apart from fishes, this dryer is also suitable for other agricultural products like fruits, vegetables and spices.

Fig.4 CIFT Solar-Tunnel Dryer

**(e) Solar Cabinet dryer with electrical back-up:** This offers a green technology supplemented by electrical back up in case of lacunae in solar radiation. The dryer consists of four drying chambers with nine trays in each chamber (Fig.5). The trays made of food grade stainless steel are stacked one over the other with spacing of 10 cm. The perforated trays accomplish a through flow drying pattern within the dryer which enhances drying rates. Solar flat plate collectors with an area of 7 $m^2$ transmit solar energy to the air flowing through the collector which is then directed to the drying chamber. The capacity of the dryer is 40 kg. Electrical back up comes into role once the desired temperature is not attained for the drying process, particularly during rainy or cloudy days.

Fig.5. CIFT Solar-Cabinet Dryer with Electrical back-up

**(f) Infrared drying** – CIFT has recently developed an Infra Red (IR) dryer heat transfer is happening by radiation between a hot element (infrared lamps) and a material (to be dried). Thermal radiation is considered to be infrared in the electromagnetic spectrum between the wavelength of 0.78 µm and 1000 µm. Infrared emitters offer efficient heat and much more advantages compared to other conventional heat technologies:

- No direct contact with the product
- High drying/heating rate
- Infrared radiation can be focused where it is needed in a defined time,
- Cost savings thanks to high overall efficiency and optimal infrared heaters lifetime.

## 1.2 Fish Descaling Machines

**(a) Fish descaling machine with variable drum speed:** Fish de-scaling machine is designed and fabricated for removing the scales of fishes easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardine, Tilapia to Rohu. The machine is made of SS 304 and has 10 kg capacity. It contains a 1.5 HP induction motor and a Variable Frequency Drive (VFD) to vary the speed of the drum depending on the variety of the fish loaded. The drum is made of perforated SS 304 sheet fitted in a strong SS Frame. Water inlet facility is provided in the drum for easy removal of the scales from the drum so that area of contact to the surface will be more for removal of scales. The water outlet is also provided to remove scales and water from the machine. An Electronic RPM meter was attached with the de-scaling machine which directly displays the RPM of the drum. Speed of the drum is a factor influencing the efficiency. The machine takes only 3-5 minutes to clean 10 kg fish depending on the size.


Fig.6  Fish de-scaling machine with variable drum speed

**(b) Fish de-scaling machine with fixed drum speed- table top:** Fish de-scaling machine is designed and fabricated for removing the scales of fishes easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardine, Tilapia to Rohu. This machine is made of SS 304 and has 5 kg capacity. It contains a 0.5 HP AC motor with proper belt reduction mechanism to achieve required drum speed of 20-30 rpm. Body is fabricated in dismantling type one-inch square SS tube with a suitable covering in the electrical parts. The drum is made of perforated SS sheet fitted in a strong SS Frame having suitable projections to remove the scale and provided with a leak proof door with suitable lock.

**(c ) Fish de-scaling machine hand operated:** Fish de-scaling machine is designed and fabricated for removing the scales of fishes easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardine, Tilapia to Rohu (Fig.7). This machine is made of SS 304 and has 5 kg capacity.  Body is fabricated in dismantling type 1 inch square SS tube. The drum of 255.5 mm diameter and 270 mm length is made of perforated SS sheet fitted in a strong SS Frame having suitable projections to remove the scale and provided with a leak proof door with suitable lock. A pedal is fitted in the side to rotate the drum manually.

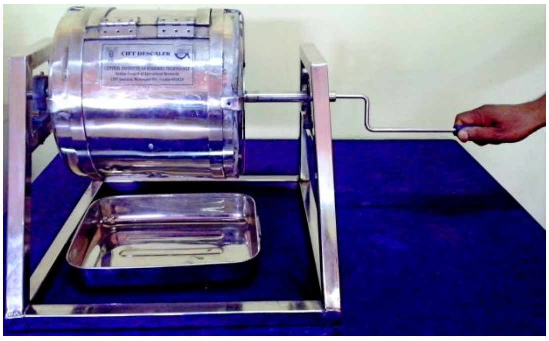

Fig.7 Fish de-scaling machine hand operated

1.3 **Fish meat bone separator:** A Fish Meat Bone Separator with variable frequency drive (VFD) to separate pin bones from freshwater fishes was designed and developed. This can be used at a range of 5-100 rpm. With a unique belt tighten system developed; the new machine can be easily adapted to any species and need not be customised for specimen during design stage. In existing imported models, only two speeds are possible which restricts the yield efficiency in a single span operation and also limits easy switching of the system for utilising specimen other than for which the yield has been originally customised. The meat yield of this machine was about 60% against 35% in imported models. Capacity of the machine is 100kg/hour.

**1.4 Modern Hygienic Mobile fish vending kiosk:** Most of the fisher folk across India sell fish in an open basket without any hygienic practices. The fish is kept in an open bag or container, it loses its freshness.They use ice purchased at high cost for temporary preservation and at the end of the day, if the fish is not sold, they give it at a low rate to customers with little or no profit. More over fish gets contaminated under unhygienic handling practices. The fish vending persons, especially women folk find it difficult to carry the fishes as head load and subsequently sell it in the local markets or consumer doorsteps. In this context, the ICAR-CIFT have designed and developed a mobile fish vending kiosk for selling fish in the closed chilled chamber under hygienic conditions at consumer doorstep.

The major advantages of the new Kiosk are as follows:

- The mobile kiosk was designed considering the maximum weight that a man pulls on rickshaw.
- The mobile unit is mounted on frame with wheels at the bottom. The kiosk can carry 100kg fish with 20kg under chilled storage display in glass chamber and remaining in insulated ice box (developed by CIFT).
- The main components of the kiosk are fish storage & display chilled glass chamber, hand operated descaling machine and fish dressing deck with wash basin, water tank, cutting tool, waste collection chamber and working space.
- The vending unit has been fabricated mainly using stainless steel (SS 304 Food Grade) and frame and supports are made with MS and GI sheets.
- The kiosk main part *i.e* chilling unit & display for fish storage which was envisaged to power by solar energy through solar PV cells,however presently powered by AC current.
- The stored fish is covered with transparent glass cover through which consumer can see the fishes and select according to their choice of purchase.
- Kiosk is attached with hand operated descaling machine for removal of scales. The fishes coming out of descaler is free of scales, dirt or slime.
- It also reduces human drudgery and avoids cross contamination, consumes lesser time. Fish dressing deck with wash basin also designed conveniently to prepare fresh clean fish under hygienic conditions.

Chilling of fish using electricity/PV cells or by adding large quantity of iceadds to cost to the selling price. Since this technology has well insulated storage space for fish with provisions for refrigeration, it reduces the ice melting rate and its cost, thereby reducing the selling price. The unit also extends the keeping quality of fish for 4- 5 days and increases marginal benefit to fish vendors. It also helps change the practice of unhygienic handling and marketing of fish.

1.5 **Electronics and Instrumentation:**

ICAR-CIFT identified the vast scope of electronics and instrumentation for fisheries technological investigations and started research and development activities. This resulted in a series of instruments for systematic monitoring, analysis and assessment of the marine environment including the performance of the machineries used for harvesting the resources and post-harvest technology. Basic technologies developed in ICAR-CIFT include more than five dozens of electronic instruments with fully indigenous technology and more than 50 sensors with novel features and designs. The notable achievement is the development of indigenous sensors, which are rugged to withstand hostile marine environment and enable us to monitor field data from remote areas. The total instrumentation is built up around these sensors, with required electronics, new signal processors and other peripherals for solid-state data storing, compatibility to PC, wireless transmission to distant points *etc*.

Some of the instruments, which has got great attention and acceptance are as follows: environmental data acquisition system, freezer temperature monitor, salinity temperature depth meter, hydro meteorological data acquisition system, warp load meter, solar radiation monitor and integrator, ship borne data acquisition system, water level recorder, ocean current meter, remote operated soil moisture meter, water activity meter, rheometer and micro algae concentration monitor. Since the instruments are designed to be compatible with computer and solid-state memory module, the information can be stored for long duration and retrieved at our convenience.

By effective use of efficient and appropriate engineering technologies which are cost-effective, adaptable and environment friendly, the fishermen community as well as seafood industry can reduce the harvest and post-harvest expenses and losses, add more value to the products, ensure better fish value chain dynamics and thereby obtain more income. The use of green and clean technologies also ensures less carbon and water foot prints.

**2. Commercialization and Agri-Business Incubation**

Agri-Business Incubators (ABI) open new entry points in the agricultural value chains, which in turn can use to access new markets. They afford leverage through these entry points to accelerate agricultural development and offer the unique potential to develop small and medium-sized enterprises (SME's) which can add value along these chains in ways which other development tools do not offer. There is no single "right way" to perform agribusiness incubation. Rather the work of agribusiness incubation depends on the state of development of the agribusiness ecosystem and changes over time as that ecosystem matures and develops. In its earliest phases, incubators demonstrate the viability of new business models and look to create and capture additional value from primary agricultural products. In underdeveloped agricultural economies, incubators help by strengthening and facilitating linkages between enterprises and new commercial opportunities. They open new windows on technologies appropriate to agribusiness enterprises and help agricultural enterprises discover new, potentially more competitive ways of doing business. In subsequent phases of development, incubators operate as network facilitators: they link specialized service providers to agribusinesses and link separate agribusinesses to one another. Finally, in a more advanced state of business development, incubators operate as conduits for the exchange of technology, products, inputs and management methods across national borders.

A more pragmatic system for business incubation and promoting start-up companies with respect to agricultural technologies have been evolved in recent times within the ICAR-CIFT.The Agri-Business Incubation (ABI) center along with Institute Technology Management Unit (ITMU) seeks to provide business consulting services to agriculture-related businesses and helps to develop a strategic business plan. ABIs facilities for incubation of new business ideas based on new agricultural technologies by providing cheap space, facilities and required information and research inputs. The Agribusiness Incubator Program also seeks to provide business consulting services to agriculture-related businesses and helps to develop a strategic business plan.

The Engineering Division of ICAR-CIFT has commercialized its technologies like solar fish dryers, fish descaling machines, refrigeration enabled fish vending machines etc through the ABI. In the financial year 207-18 itself, two entrepreneurs have taken up Solar fish drying technology and three start-ups came up by establishing CIFT designed fish vending kiosks. Three firms fish descaling machines were also successfully handed over to sea-food industries located both in Andhra Pradesh and Kerala. Apart from these, 10 numbers of fish dryers of 10 kg capacity were distributed among women SHG groups located in Kerala, Manipur and Assam for demonstration purposes. Furthermore, 3 incubatees( one physical and two virtual) have already registered under ABI in the current year for using engineering technologies.

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# Chapter 7

## Microbiological safety and quality of fish and fishery products

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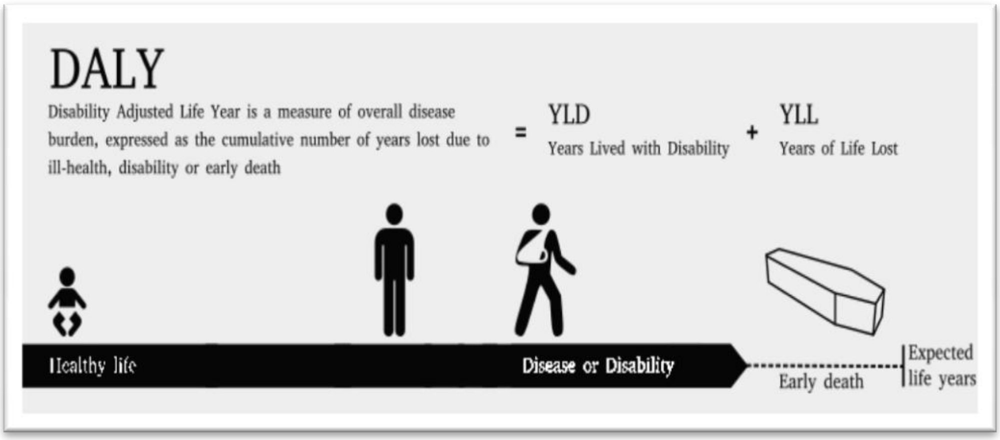
The continued occurrence of foodborne illness is not evidence of the failure of our food safety system. In fact, many of our prevention and control efforts have been and continue to be highly effective. In advanced countries like US where food supply is one of the safest in the world, however, significant food borne illness continues to occur. Despite great strides in the area of microbiological food safety, much remains to be done. In under developed and developing countries of Asia, Africa and Latin American Countries in the absence of good surveillance programs the task is much more complicated especially catering to needs of microbial safety of foods of billions of populations.

Food-borne disease outbreaks are defined as the occurrence of 2 or more cases of a similar illness resulting from ingestion of a common food or observed number of cases of a particular disease exceeds the expected number. These can be confirmed (when at least one causal agent is identified) or suspected (based on clinical and epidemiological information). Although most cases are sporadic, these diseases draw attention to themselves due to outbreaks, thorough investigation of which can help in identifying control measures.

Annual burden of foodborne diseases in the WHO South- East Asia Region includes more than: • 150 million illness • 175 000 deaths • 12 million DALYs Source: FERG Report 2010

The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. It was developed in the 1990s as a way of comparing the overall health and life expectancy of different countries.

The DALY is becoming increasingly common in the field of public health and health impact assessment (HIA). It "extends the concept of potential years of life lost due to premature death...to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability." In so doing, mortality and morbidity are combined into a single, common metric.




Despite significant success at improving the safety of the food supply, current science on which safety is based does not sufficiently protect consumers from emerging issues inherent to a complex food supply. The evolving characteristics of food, technology, pathogens and consumers make it unlikely the marketplace will be entirely free of dangerous organisms at all times for all consumers. This is the conclusion made in the report, Emerging Microbiological Food Safety Issues: Implications for Control in the 21$^{st}$ Century was released today at IFT's International Food Safety and Quality Conference and Expo in Atlanta one and half decades back.

The report, drew upon experts specializing in food borne pathogens and microbial evolution, food borne illness, food production and processing, testing methods and regulatory measures, reveals that diligent adherence to current methods that create and monitor the food supply cannot eliminate the risk of food borne illness. The report also offered the recommendations for providing the greatest possible reduction in food safety risks.

**Among its seven important issues addressed were**:

1. Procedures from farm to table to significantly reduce illness due to mishandling,
2. Processes to recognize and respond to outbreaks and to reduce their scope.
3. Poor habits that make consumers more susceptible to foodborne illness,
4. Education and training recommendations necessary for reducing pathogenic influence at every step
5. From production to consumption (pond to plate/farm to fork
6. Recommendations to enhance monitoring, data generation, and risk assessment. &
7. The current state and future potential of rapidly evolving illness-causing pathogens and other key issues.

To gain the greatest measure of food safety, the report stressed on the necessity of implementing flexible food safety measures so as to utilize as quickly as possible the latest scientific information as it evolves. The report also urged manufacturers, regulatory and public health agencies and allied organizations to develop partnerships to improve risk assessment and food safety management.

**SEAFOOD SAFETY GOALS MUST ACHIEVE MORE THAN END-PRODUCT PROBES**

The absence of pathogens in final-product testing does not ensure food free of virulent microorganisms, according to a new expert report on food safety issues, and as pathogen contamination decreases this form of testing becomes more deficient. So as today's food safety continues to improve, more emphasis should be placed on monitoring processing capabilities and conditions through the application of science-based food systems.

The microbiological testing of finished sea food products and can be misleading for the following reasons

1. Due to statistical limitations based on the amount of product sampled,
2. The percentage of product contaminated, and
3. The uniformity of the contamination distributed throughout the food.

The above mentioned negative results imply an absence of pathogens in foods, the report states, and can cause consumers to assume proper food selection and handling practices are unnecessary. Instead, the report urges everyone along the farm-to-fork seafood chain to be responsible for an important role in food safety management.

According to Douglas L. Archer of the University of Florida who contributed to IFT report "Current safety evaluations focus on microbes that may or may not be harmful to humans," he added, "For example, some subtypes of *Listeria monocytogenes* found in or on food may not be associated with food borne illness. Yet their mere detection can be grounds for legal action against the manufacturer and force recalls of food that is unlikely to cause illness in the general population."

The need science-based approach called Food Safety Objectives that would place specific values on public health goals, with reassurances those values are reached at key points along the pond to plate process. Those values would be flexible as hazards and public health goals change, science progresses, and unfettered data sharing improves, allowing for the quickest implementation of new safety improvements as they evolve, and a safer food supply.

The report urges intentional interaction of public health, regulatory, industrial and consumer agencies, calling the implementation of a flexible, science-based approach involving all these parties "as the best weapon against emerging microbiological food safety issues."

**Steps in seafood Safety Management**

Foodborne illness in India is a major and complex problem that is likely to become a greater problem as we become a more global society where every 5$^{th}$ person walking on this planet is going to be Indian. Nearly 10 million foodborne illnesses occur per year in India. To adequately address this complex problem, the need is to develop and implement a well-conceived strategic approach that quickly and accurately identifies hazards, ranks the hazards by level of importance, and identifies approaches for microbial control that have the greatest impact on reducing hazards, including strategies to address emerging hazards that were previously unrecognized.

**Policy Development**

Scientific research has resulted in significant success in improving seafood safety, but the current science supporting the safety of our seafood supply is not sufficient to protect us from all the emerging issues associated with the complexity of the food supply. As new issues emerge, some will be best addressed through the application of control technologies during seafood production and processing, but others may be best addressed at the consumer level through modification of exposure or susceptibility.

Food safety policies should be developed as part of national initiatives, with input from all stakeholders. In addition, international coordination of food safety efforts should be encouraged. Globalization of the food supply has contributed to changing patterns of food consumption and food borne illness, and global food trade has the potential to introduce pathogens to new geographic areas.

To achieve the maximum benefits, our food safety efforts and policies must be carefully prioritized, both in terms of research and in application of controls. As scientific advances provide a better picture of pathogenicity, the need of the hour is whether to focus the efforts on those pathogens that cause many cases of minor illness or instead focus on those pathogens with the greatest severity, despite the relatively low number of cases. In the move toward making decisions based on risk, the food safety policies need to weigh these issues, and communicate information about risk to all stakeholders, especially the public.

The body of scientific knowledge must be further developed, with the research efforts carefully prioritized to yield the greatest benefit. Food safety and regulatory policies must be based on science and must be applied in a flexible manner to incorporate new information as it becomes available and to implement new technologies quickly. The seafood industry, regulatory agencies and allied professionals should develop partnerships to improve food safety management.

**In essence**:

Seafood Supply and exports: The amount of exported seafood has increased significantly, and this trend is likely to continue. Consistent, widespread application of food safety systems, including Hazard Analysis and Critical Control Points systems and good manufacturing (GMP), must be encouraged for international trade.

New Seafood Processing Technologies and Novel sea foods. Scientists continue to be challenged to adequately address all the parameters associated with the introduction of a novel seafood or alternative processing technology. Once developed, new technologies must be appropriately used and regulated to ensure their proper application and the product's safety.

Increases in Organic Foods. The use of manure as a fish pond fertilization is a significant concern. Methods are needed to reduce the presence of pathogens in manure and to effectively eliminate them before they contaminate the aquatic environment and fish.

Changes in Food Consumption. People's changing dietary patterns affect their risk of foodborne illness. The control and prevention methods will need to be adapted to these changing dynamics. For example, in India the number of high end consumers who prefer ready to eat foods are more than 300 million which is more or less equivalent to Europe.

At-Risk populations. It is likely that the number of persons at higher risk for foodborne disease will continue to increase with time. The population of India is going to be 150 crores. In addition, there are an increasing number of transplant recipients, people undergoing treatment for cancer, people with AIDS, and others with compromised immune system function.

Pathogen Evolution. Microbial evolution has always happened and will continue to occur. Improved surveillance and new genomic technologies offer the potential to identify new potential foodborne pathogens before they cause significant illness. Another hope for the future is a better understanding of how human actions affect foodborne pathogens.

Consumer Understanding. Education and risk communication will be necessary to share with consumers our growing knowledge of food safety risks and to encourage behavior modification, where needed.

Integrated Food Safety System. A farm to- fork or pond to plate table food safety system must involve many interested parties working together toward a common goal. The challenge is to build a system that applies science in a predictable, consistent, and transparent manner to enable harmonization within and between countries The list of principal symptoms of Bacteria, potential food contamination are provided in table below.

| **List of bacterial food poisoning, symptoms and Food source** | | | | | |
|---|---|---|---|---|---|
| **Organism** | **Common Name of Illness** | **Onset Time After Ingesting** | **Signs & Symptoms** | **Duration** | **Food Sources** |
| *Bacillus cereus* | *B. cereus* food poisoning | 10-16 h | Abdominal cramps, watery diarrhea, nausea | 24-48 h | Meats, stews, gravies, vanilla sauce |
| *Campylobacter jejuni* | Campylobacteriosis | 2-5 days | Diarrhea, cramps, fever, and vomiting; diarrhea may be bloody | 2-10 days | Raw and undercooked poultry, unpasteurized milk, contaminated water |
| *Clostridium botulinum* | Botulism | 12-72 hours | Vomiting, diarrhea, blurred vision, double vision, difficulty in swallowing, muscle weakness. Can result in respiratory failure | Variable | Improperly canned foods, especially home-canned vegetables, fermented |

| | | | | | |
|---|---|---|---|---|---|
| | | | and death | | fish, baked potatoes in aluminum foil |
| *Clostridium perfringens* | Perfringens food poisoning | 8–16 hours | Intense abdominal cramps, watery diarrhea | Usually 24 hours | Meats, poultry, gravy, dried or precooked foods, time and/or temperature-abused foods |
| *Cryptosporidium* | Intestinal cryptosporidiosis | 2-10 days | Diarrhea (usually watery), stomach cramps, upset stomach, slight fever | May be remitting and relapsing over weeks to months | Uncooked food or food contaminated by an ill food handler after cooking, contaminated drinking water |
| *Cyclospora cayetanensis* | Cyclosporiasis | 1-14 days, usually at least 1 week | Diarrhea (usually watery), loss of appetite, substantial loss of weight, stomach cramps, nausea, vomiting, fatigue | May be remitting and relapsing over weeks to months | Various types of fresh produce (imported berries, lettuce, basil) |
| *E. coli (Escherichia coli)* producing toxin | *E. coli* infection (common cause of "travelers' diarrhea") | 1-3 days | Watery diarrhea, abdominal cramps, some vomiting | 3-7 or more days | Water or food contaminated with human feces |
| *E. coli* O157:H7 | Hemorrhagic colitis or *E. coli* O157:H7 infection | 1-8 days | Severe (often bloody) diarrhea, abdominal pain and vomiting. Usually, little or no fever is present. More common in children 4 years or younger. Can | 5-10 days | Undercooked beef (especially hamburger), unpasteurized milk and juice, raw fruits and vegetables (e.g. |

| | | | | | |
|---|---|---|---|---|---|
| | | | lead to kidney failure. | | sprouts), and contaminated water |
| Hepatitis A | Hepatitis | 28 days average (15-50 days) | Diarrhea, dark urine, jaundice, and flu-like symptoms, i.e., fever, headache, nausea, and abdominal pain | Variable, 2 weeks-3 months | Raw produce, contaminated drinking water, uncooked foods and cooked foods that are not reheated after contact with an infected food handler; shellfish from contaminated waters |
| *Listeria monocytogenes* | Listeriosis | 9-48 h for gastro-intestinal symptoms, 2-6 weeks for invasive disease | Fever, muscle aches, and nausea or diarrhea. Pregnant women may have mild flu-like illness, and infection can lead to premature delivery or stillbirth. The elderly or immunocompromised patients may develop bacteremia or meningitis. | Variable | Unpasteurized milk, soft cheeses made with unpasteurized milk, ready-to-eat deli meats |
| Noroviruses | Variously called viral gastroenteritis, winter diarrhea, acute non-bacterial gastroenteritis, food poisoning, and food infection | 12-48 h | Nausea, vomiting, abdominal cramping, diarrhea, fever, headache. Diarrhea is more prevalent in adults, vomiting more common in children. | 12-60 h | Raw produce, contaminated drinking water, uncooked foods and cooked foods that are not |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | reheated after contact with an infected food handler; shellfish from contaminated waters |
| *Salmonella* | Salmonellosis | 6-48 hours | Diarrhea, fever, abdominal cramps, vomiting | 4-7 days | Eggs, poultry, meat, unpasteurized milk or juice, cheese, contaminated raw fruits and vegetables |
| *Shigella* | Shigellosis or Bacillary dysentery | 4-7 days | Abdominal cramps, fever, and diarrhea. Stools may contain blood and mucus. | 24-48 h | Raw produce, contaminated drinking water, uncooked foods and cooked foods that are not reheated after contact with an infected food handler |
| *Staphylococcus aureus* | Staphylococcal food poisoning | 1-6 hours | Sudden onset of severe nausea and vomiting. Abdominal cramps. Diarrhea and fever may be present. | 24-48 hours | Unrefrigerated or improperly refrigerated meats, potato and egg salads, cream pastries |
| *Vibrio parahaemolyticus* | *V. parahaemolyticus* infection | 4-96 hours | Watery (occasionally bloody) diarrhea, abdominal | 2-5 days | Undercooked or raw seafood, such as |

| | | | | | |
|---|---|---|---|---|---|
| | | | cramps, nausea, vomiting, fever | | shellfish |
| *Vibrio vulnificus* | *V. vulnificus*infection | 1-7 days | Vomiting, diarrhea, abdominal pain, blood borne infection. Fever, bleeding within the skin, ulcers requiring surgical removal. Can be fatal to persons with liver disease or weakened immune systems. | 2-8 days | Undercooked or raw seafood, such as shellfish (especially oysters) |

**Need for Quality Improvement in Fish**

QUALITY ISO 9000:1989; ISO8402
DEFINITION: The Totality of Features and Characteristics of a Product or Service that Bear on its Ability to Satisfy Stated or Implied Needs

*QUALITY ISO 9000:2000 DEFINITION:*
Ability of Complete Set of Realized Inherent Characteristics of a Product System or Process to fulfil Requirements

| **Underutilization of conventional fish stocks (in million tons)** | | |
|---|---|---|
| Wet fish | Post-harvest losses | 2 |
| Cured fish | Post-harvest losses | 3 |
| By-catch | Discarded at sea | 5-20 |
| Pelagic fish | Used for fish meal | 20 |
| Pelagic fish | Under exploited | 20 |

| **Degree of losses under different climatic conditions** | | | |
|---|---|---|---|
| Loss causing agent | Dry (but possibly With overnight dew) | Humid | Rainy |
| Spoilage prior to Processing | Low | Low to moderate | High |
| Blowfly | Low | Moderate to high | High |
| Halophilic bacteria and molds | Low to moderate | Moderate to high | High |

| | | | |
|---|---|---|---|
| Beetle infestation | Moderate to high | Moderate | Low (relatively) |

| Factors contributing to outbreaks of fish borne disease | |
|---|---|
| Contributing factors | Percentage [a] |
| Factors relating to microbial growth | |
| Storage at ambient (room) temperature | 43 |
| Preparation too far in advance of serving | 41 |
| Improper warm holding | 12 |
| Use of leftovers | 5 |
| Extra large quantities prepared | 22 |

| Factors contributing to outbreaks of fish borne disease | |
|---|---|
| Contributing factors | Percentage [a] |
| Factors relating to microbial survival | |
| Improper reheating | 17 |
| Inadequate cooking | 13 |
| Factors relating to contamination | 12 |
| Food workers | 7 |
| Contaminated raw foods | 11 |
| Cross-contamination | 7 |
| Inadequate cleaning of equipment | 5 |
| Unsafe source | |

| Food hazards: Perception of the consumer verses epidemiological data | | |
|---|---|---|
| Case | Perception | Relative importance |
| Microbial contamination | 22 | 49.9 |
| Nutritional imbalance | | 49.9 |
| Environmental contaminants | 31 | 0.05 |
| Natural toxins | 10 | 0.05 |
| Food additives | 30 | 0.0005 |
| Others, e.g., packaging materials | 7 | |

| Chlorine use in different stages | |
|---|---|
| **Purpose** | **In PPM** |
| Washing for processing | 5-10 |
| For making ice | 5-10 |
| To disinfect after washing with detergents | 100 |
| Washing floor s and gutters | 500-800 |
| Washing product | 10 |
| Washing of boat deck, fish holds and wooden boxes. | 1000 |
| Cleaning of fish containers, carrier vans, refrigerated wagons | 100 |
| Washing of utensils, processing tables etc | 100 |
| washing of hands | 20 |

| Spoilage characteristics of some dry salted fish products | | |
|---|---|---|
| **Variety** | **Product** | **Spoilage type** |
| Tuna | Dry salted | Off –odour (OO) |
| Mackerel | -do- | Pink –discolouration (PD) |
| Seer | -do- | Halophilic bacteria |
| Horse mackerel | -do- | Free from PD & no OO |
| Shark | -do- | OO&PD |
| Thread fin | -do- | OO&PD |
| Cat fish | -do- | OO,PD, clinging salts |
| Prawns | Dried | OO |
| Bombay duck | laminated | Grey white colour, OO &PD |

***BASIC PRECAUTIONS TO IMPROVE QUALITY OF CURED FISH***

- Select good quality fish
- Clean the fish with freshwater
- Eviscerate the fish properly
- Select good quality salt

- Proper drying of fish need to be done
- Employ proper dryers
- Protect the fish adverse conditions: rain, birds, animals etc.
- Proper packaging and
- Proper storage

***TOOLS FOR QUALITY IMPROVEMENT***

- Empowerment
- Benchmarking
- Kaizen (Continuous improvement approaches)
- 6-Sigma applications
- 5-S A requirement for TQM
- Good manufacturing Practices (GMP)
- Hazard Analysis Critical Control Point (HACCP)

***5S GOOD HOUSEKEEPING***

- Sort: take out unnecessary items and dispose
- Systematize: Arrange necessary items in good order
- Sweep: Clean your work place
- Standardize: Standardize the process of sorting, arranging and cleaning
- Self-discipline: Do things spontaneously as a habit.

***EVOLUTION OF THE QUALITY PROFESSION***

- ’50s---Inspection & Conformance to specification
- ’60s---Customer requirements or fitness for use
- ’70s---Human dimensions of quality (Quality people do quality work)
- ’80s---Relationships at the work place (Quality work depends on quality of work life)
- ’90s--- partnerships between employees, customers and stakeholders.
- 2010: management of Data, Information and Knowledge

***5M’s of Quality***

- Manpower
- Materials
- Methods
- Machines
- Measurement

***5r’S OF UNQUALITY***

- Reject

- Rework
- Return
- Recall
- Regrets

***PPM OF QUALITY RESPONSIBILITY***

- Planning
- Prevention
- Monitoring

***DIFFERENT LEVELS OF QUALITY PRACTICE***

- LEVEL 1- QUALITY AWARENESS (QAW)
- LEVEL II- QUALITY CONTROL (QC)
- LEVEL III- TOTAL QUALITY CONTROL (TQC)
- LEVEL IV- TOTAL QUALITY MANAGEMENT (TQM)
- LEVEL V-PARTNERSHIPS FOR QUALITY, PRODUCTIVITY AND PROFITABILITY (PQP2)

***PRINCIPLES OF TOTAL QUALITY MANAGEMENT***

- A Aim for customer satisfaction
- C Communicate and coordinate allactivities
- C Commit and cooperate towards improvement
- E Empower the employees
- P Promote use of problems solving tools
- T Training for quality is forever

***STAGES IN TQM DEVELOPMENT***

- G Get management commitment
- R Review recorded procedures
- A Assess quality practices
- C Compare records and practice
- E Evaluate results

- O Overview total situation
- F Find areas requiring improvement

- G Get fully involved
- O Out do your own performance
- D Document changes in procedures

- A Assessment,identificationand preparation
- M Management, understanding and commitment
- E Energizing for improvement
- N New initiatives, new targets and critical monitoring

***REQUISITES FOR TOTAL QUALITY COMMITMENT***

- C Customer orientation whether inside or outside the set up
- H Human resource striving for excellence
- A Acquisition of products and process leadership
- M Management leadership for quality
- P Practice quality as a way of life inside and outside work place
- S Sustained quality culture in the company

***CARES***

- C Communicate management plans for quality
- A Accessibility to one another in the organization
- R Revitalization of problem solving capabilities
- E Embarrassments are avoided if all agree that inspection is not the way to achieve quality
- S Sustain the desire to personally commit to quality

***CODE OF CONDUCT IN TEAM MEETING***

- Cooperate with each other
- Listen to other's ideas
- Keep an open mind
- No personal attacks
- Stick to the facts
- Every one participates
- Be tactful, be honest
- No hidden agendas

***IMPORTANCE OF DELIVERING BOTH QUALITY PRODUCTS AND SERVICE***

- 68% customers stop purchases due to poor service
- Customers are five times more likely to leave for poor service than poor product quality or high cost
- The average unhappy customer tells nine other people about experience
- When 50 to 75% of the complaints attended to 95% unhappy customers can be saved
- Average happy customer tells five other

**Costliest Tuna as case study**

Kiyomura Co's sushi chefs react to a part of a 222 kg (489 lbs) Bluefin tuna after cutting its meat at the company's sushi restaurant outside Tsukiji fish market in Tokyo January 5, 2013. The tuna was sold nearly for 1.8 million USD and when it converted into local currency what could be cost of whole of 222kg, per/kg and also with 74% meat amounting to 164.28kg and per kg of the same is provided in the Table below.

| Costliest Bluefin Tuna sold for 1.8 million USD and when it is converted into local currency what could be cost of whole of 222kg, per/kg and also with 74% meat amounting to 164.28kg and per kg | | | | | | |
|---|---|---|---|---|---|---|
| S. No | Country (currency) | Local currency to USD | USD to local currency | A 222Kg Bluefin tuna cost | Per Kg out of 222kg | With 74% meat yield ratio 164.28 weight cost per/kg |
| 1 | Afghanistan (Afghani) | 75.97 | 0.013 | 136,746,000 | 615,972.97 | **832,395.91** |
| 2 | Algeria (Dinar) | 118.61 | 0.0084 | 213,498,000 | 961,702.70 | **1,299,598.25** |
| 3 | Bangladesh (Bangladeshi Taka) | 83.79 | 0.012 | 150,822,000 | 679,378.37 | **918,078.88** |
| 4 | Guatemala (Guatemalan Quetzal) | 7.69 | 0.13 | 13,842,000 | 62,351.35 | **84,258.58** |
| 5 | Malawi (Malawi kwacha) | 727.22 | 0.085 | 1,308,996,000 | 5,986,378.37 | **7,968,078.88** |
| 6 | Mauritius (Mauritian rupee) | 34.47 | 0.029 | 62,046,000 | 279,486.49 | **377,684.44** |
| 7 | Oman (Oman Rial) | 2.60 | 0.38 | 684,000 | 3081.08 | **4163.22** |
| 8 | Sri Lanka (Sri Lankan rupee) | 175.13 | 0.0058 | 315,234,000 | 1,419,972.97 | **1.918,882.39** |
| 9 | Sudan (Sudanese pound) | 47.62 | 0.021 | 85,716,000 | 386,108.10 | **521,767.71** |
| 10 | Syria (Syrian Pound) | 514.93 | 0.0019 | 926,874,000 | 4,175,108.11 | **5,642,037.98** |
| 11 | Tanzania (Tanzania Shilling) | 2290.40 | 0.00044 | 4,122,720,000 | 18,570,810.81 | **25,095,690.28** |
| 12 | Tunisia (Tunisian | 2.91 | 0.034 | 5,238,000 | 23,595.00 | **31,884.59** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Dinar) | | | | | |
| 13 | Uganda (Ugandan Shilling) | 3766.70 | 0.00027 | 6,780,060,000 | 30,540,810.81 | **41,271,365.96** |
| 14 | Zimbabwe | 361.9 | 0.002763 | 651,420,000 | 2,934,423.32 | **3,965,303.14** |

# Chapter 8

## Wealth from fish waste:CIFT interventions

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Processing of fish for human consumption results in enormous quantity of waste in the form of skin, head, viscera, scales, bones, trimmings and frames. The quantity of waste generated depends on the type and size of fish and the product manufactured out of it. Industrial fish processing for human consumption yields only 40% edible flesh and the remaining 60% is thrown away as waste. Annual discard from the world fisheries were estimated to be approximately 20 million tonnes (25%) per year which includes “waste” or by-products also. The immense scope for high end product from fishery waste has been realized and different technologies have been developed with a view to utilize processing waste, for converting them into products for human consumption, animal nutrients and products of pharmaceutical and nutraceutical significance. Among the most prominent current uses for fish waste are fishmeal production, extraction of collagen and antioxidants, isolation of cosmetics, biogas/biodiesel, production of chitin and chitosan, food packaging (gelatin, chitosan) and enzyme isolation. Fish waste is prone to very faster spoilage since it contains easily digestible protein. The microbial population associated with the digestive process are the major reasons of spoilage. Since the processor does not bother to preserve the waste the problem of environmental pollution is enhanced. Accumulation of fishery waste results and rodents and results in nauseating and obnoxious smell due to the release of volatile nitrogenous compounds during decomposition.

**Fish meal**

Fish meal is highly concentrated nutritious feed supplement consisting of high quality protein, minerals, vitamins of B group and other vitamins and other unknown growth factors. Fishmeal is rich in essential amino acids. It is produced by cooking, pressing, drying and grinding the fish, by-catch fish, miscellaneous fish, filleting waste, waste from canneries and waste from various other processing operations. The composition of fishmeal differs considerably due to the variations in the raw material used and the processing methods and conditions employed.

Traditional fishmeal production in India was from the sun dried fish collected from various drying centres and the products were mainly used as manure. Better quality fish meal has been a prominent item of export from the very beginning of this industry. BIS has brought out the specification for fish meal as live stock feed for facilitating proper quality control.

The proximate composition of fish meal in general is given below:

Protein - 50-57%

| | | |
|---|---|---|
| Fat | - | 5-10% |
| Ash | - | 12-33% |
| Moisture | - | 6-10% |

**Manufacturing process**

Fish can be reduced by two general process (1) Dry rendering (2) Wet rendering process.

**Dry Rendering Process**

Dry rendering or dry reduction process is suitable for only lean or non oil fish such as silver bellies, jew fish, sciaenids, ribbon fish, sole, anchoviella, carcasses of shark, fish offal and filleting waste. In this process, it is dried to moisture content of 10% and pulverized. If the quantity to be handled is sufficiently large a steam jacketed cooker dryer equipped with power devises for stirring is used. Sometimes, if the size of the fish is comparatively large a coarse grinding is also done before being fed into the cooker drier. The cooker dryer may be operated at atmospheric pressure or under partial vacuum. Being batch operation the process will have only limited capacity and labour cost is very high. Merit of this process is that the water-soluble materials are retained in the meal.

**Wet rendering process**

Wet rendering or wet reduction process is normally applied to fatty fish or offal where simultaneous production of fish meal and fish body oil is envisaged. The process consists of grinding, cooking to soften the flesh and bones and to release the oil, pressing to expel the liquor and oil, fluffing the press cake drying, grinding and packing the meal, The press liquor is centrifuged to remove the suspended particles and to separate oil. The stick water is concentrated. The process requires elaborate equipment and is normally a continuous one and therefore adaptable to the reduction of large quantities of fish.

In a continuous wet reduction process the coarsely ground fish or fresh raw fish or offal is passed through a stationary horizontal cylindrical cooker by means of a screw conveyor at a predetermined rate. Steam is admitted through a series of jets. The cooked mass is passed through a continuous screw press. The press cake is fluffed and dried to a moisture level of 8%. The suspended fish meal present in the press liquor is separated by centrifugal sedimentation and the oil by centrifugation or other conventional methods.

**Fish body oil**

The main source of fish body oil in our country is oil sardine. A survey of the oil industry reveals that the extraction is done on a cottage scale in isolated places near the leading centres and is not well organized. The method of extraction followed is cooking the fish in iron vessels and pressing and separating the oil. Apart from sardine oil, fish body oil is also obtained from the fish meal plants operating in the country. In India oil sardine is a fishery which exhibited wide fluctuations from as low as 1% to as high as 32% of the total landings. The seasonal variation in oil content is predominant in Kerala and Karnataka coast. During the peak season fish has oil content of 17%. By the wet rendering process the fish will yield, on average 12% oil having analytical characteristics similar to other fish oils. Fatty acid composition of oil revealed that they contain high amounts of polyunsaturated fatty acids (PUFA). At present the medicinal values of fish oils are well known.

**Fish liver oil**

The therapeutic values of fish liver oil were discovered in 18th century and fish liver oil becomes a common medicinal product especially for Vitamin A and D. Cod, shark and haddock livers are the important sources of Vitamin A and D. The weight of liver, fat content and presence of vitamins are dependent on a number of factors like species, age, sex, nutritional status, stages of spawning, and area from where it is caught.

In cod (Gadus collarius), coal fish (Pollahius vireus) and haddock (Melanggrammus aenglefinus), the weight of liver normally amount to 4-9% of whole fish and livers contain about 45% to 67% oil. The species of shark such as dog fish (Squalus acanthias), Greenland shark (Somniosus microcephalus) and barking shark (Certrohinus maximus) have large fatty livers weighing up to 10-25% of the whole fish containing 60-75% oil. But halibut, tuna, and whale have 1% liver having 4 to 25% oil with high vitamin A & D content. Depending on the oil content and vitamin A potency fish livers are generally classified in to three groups.

Low oil content - high vitamin A potency
High oil content - low vitamin A potency
High oil content - medium vitamin A potency

**Processing**

The processing procedures of fish liver without affecting the quality of the oil extracted can be summarized as (1) steaming (2) solvent extraction and (3) alkali/enzyme/acid digestion. The process selected should depend on the vitamin and oil content of the livers.

Certain species of shark contain high oil content with high hydrocarbon content, viz. squalene. Squalene a highly unsaturated aliphatic hydrocarbon is present in certain shark liver oils, mainly of the family squalidae, cod and some vegetable oils like olive oil, wheat gum oil, and rice bran oil. Chemically it is known as 2,6,10,15,19,23 hexamethyl, 2,6,10,14,18,22 tetracosahexane having a molecular weight of 410.70, it is an isoprenoid compound containing six isoprene units.

**Presentation and storage**

Vitamin oils are stored in rust free, well washed and dried air tight drums. The head space should be kept minimum to avoid oxidation. It is advisable to fill head space with inert gas such as nitrogen. If properly processed and stored the oil will remain in satisfactory condition without the use of preservative. Small amounts of antioxidants like BHA, □ tocopherol, BHT, NDGA can be usedto preserve the oil for longer periods.

**Fish hydrolysates**

This is also liquefied fish product but it differs from silage. These are produced by a process employing commercially available proteolytic enzymes for isolation of protein from fish waste. By selection of suitable enzymes and controlling the conditions the properties of the end product can be selected. Hydrolysates find application as milk replacer and food flavouring agents. Enzymes like papain, nicin, trypsin, bromelein, pancreatin are used for hydrolysis of fish protein. The process consists of chopping, mincing, cooking, cooling to the desired temperature, hydrolysis, sieving, pasteurizing the liquid, concentrating and vacuum drying or spray drying of the product. This is deliquescent, so care should be taken to keep it in fine airtight bottles. It can be incorporated in to beverages as a high energy drink for children and convalescent persons.

**Fish maws and isinglass**

The world isinglass is derived from the Dutch and German words, which have the meaning sturgeon's air bladder or swimming bladders. Not all air bladders are used for this preparation. The air bladder of deepwater hake is most suitable for production of isinglass. In India air bladders of eel and catfishes are used for the production of isinglass.

The air bladders are separated from fish and temporarily preserved in salt during transport. On reaching the shore they are split open, washed thoroughly, outer membrane is removed by scraping and then air dried. Cleaned, desalted, air dried and hardened swimming bladders (fish maws) are softened by immersing in chilled water for several hours. They are mechanically cut into small pieces and rolled or compressed between hollow iron rollers that are cooled by water and provided with scraper for the removal of any adhering dried material. The rolling process converts the isinglass into thin strips or sheets of 1/8 to ¼" thickness. There are processes for the production of isinglass in powder form also. Isinglass dissolves readily in most dilute acids or alkalis, but is insoluble in alcohol. In hot water isinglass swells uniformly producing opalescent jelly with fibrous structure in contrast to gelatin. It is used as a clarifying agent for beverages like wine, beer, vinegar etc. by enmeshing the suspended impurities in the fibrous structure of the swollen isinglass.

India exports dried fish maws, which form the raw material for the production of isinglass and other such products. Process has been developed to produce the finished products from fish maws.

**Fish Gelatin**

Skin of fish constitute nearly 3% of the total weight and is suitable for the extraction of gelatin. Bones and scales can also be processed into gelatin. The process involves alternate washing of skin with alkali and acid and extracting gelatin with hot water. Gelatin finds applications in pharmaceitucal products as encapsulation and in food industry as gelling agent. Fish gelatin has better release of a product's aroma and flavor with less inherent off-flavor and off-odor than a commercial pork gelatin.

**Fish calcium**

The recommended daily intake of calcium is 1000 mg for the adults, and 1300 mg for elderly women. Fish bones and scales are excellent source of calcium. Whole small fish or fish bone/scale can be used for calcium separation. The filleting frames of carps and other fishes can be used for extraction of calcium. The frames are washed and boiled to separate the adhering meat portions. It is washed again and treated with enzymes to remove the adhering connective tissue, washed, dried and powdered. Fish calcium is essentially dicalcium phosphate which has better nutritional qualities.

**Hydroxy apatite**

The hydroxy apatite extracted from the scale are having uses as bioceramic coatings and bone fillers. The coatings of hydroxyapatite are often applied to metallic implants to alter the surface properties so as to avoid rejection by the body. Similarly hydroxyapatite can be employed in forms such as powders, porous blocks or beads to fill bone defects or voids. For permanent filling of teeth hydroxy apatite is found to be a better option for import substitution.

**Utilization of prawn shell waste**

The head and shall of prawn and other crustaceans form the major fishery waste. The waste contains a good percentage of protein and chitin other than minerals. The protein can be extracted along with the flavour bearing compounds and converted into shrimp extract having potential use as a natural flavouring material. Chitosan, a deacetylated chitin, is one of such products, which has application in many fields. It is a modified natural carbohydrate polymer. It is a cationic polyelectrolyte, insoluble in water, organic solvents and alkaline solutions and is soluble in most organic acids, and dilute mineral acids except sulphuric acid. It can form ionic bonds and films. Chitosan finds applications in many industries.

**Chitin**

The residual shell waste obtained after extraction of protein with hot 0.5% caustic soda may contain small amounts of protein. This is then removed by boiling with 3% caustic soda for few minutes and filtering off the liquor. It should be washed free of alkali before demineralisation. The demineralization is done by treatment with dil. hydrochloric acid at room temperature. Demineralization reduces the volume of the shell considerably and therefore deproteiniser can hold more material if the demineralization is done initially.

**Glucosamine hydrochloride**

Chitin can be hydrolysed to glucosamine hydrochloride by adding concentrated hydrochloric acid and warming until the solution no longer gives opalescence and diluting with water. The excess acid can be distilled off under vacuum. The crude glucosamine hydrochloride is diluted with water and clarified with activated charcoal. The solution is filtered and evaporated under vacuum. The crude glucosamine hydrochloride can be separated by adding alcohol.

**Chitosan**

Chitin is dried or centrifuged or pressed to remove water. The deacetylation is done by heating at 90-95° C with 40% (w/w) caustic soda for 90-120 min. The water present in the chitin cake should also be taken in to account while preparing caustic soda solution. To achieve this 50% caustic soda is prepared and calculated quantity of it is added to the chitin cake. The reaction is followed by testing the solubility of the residue in 1% acetic acid. As soon as the dissolution is completed caustic soda is removed from the reaction mixture. The drained caustic soda can be reused for the next batch of deacetylation by fortification if necessary. The residue is washed with water free of alkali. It is then centrifuged and dried in the sun or an artificial drier at a temperature not exceeding 80° C and pulverized to coarse particles.

Chitosan is almost colourless, light in weight and soluble in dilute organic acids but soluble in water, alkali and organic solvents. It gives viscous solution when dissolved in dilute organic acids such as formic acid, acetic acid etc. Chitosan finds extensive applications in following areas viz; Food industries, Pharmaceutical applications, Chemical industries, Dental and surgical uses as a haemostatic agent, Wound healing, Biodegradable films as a substitute for artificial skins for removing toxic heavy metals, Wine clarification, Industrial Effluent Treatment, Agriculture, Photography, Cosmetic Applications and Textiles, and in nano applications.

**Fish silage**

Fish silage is defined as a product made from whole fish or parts of the fish to which no other material has been added other than acid and the liquefaction of the fish is brought about by enzymes present in the fish. The product is a stable liquid with a malty odour which has very good storage characteristics and contains all the water present in the original material. It is a simple process and it requires little capital equipment particularly if non oily fish are used. The use of oily fish requires oil separation. This involves expensive equipment and is suited to fairly large scale operation. Almost any species of fish can be used to make fish silage though cartilaginous species like shark and ray liquefy slowly. Fish waste, cuttle fish/squid waste can be used for the preparation of silage. The production of silage involves preferably organic acids like formic acid (35kg/tonne) to preserve the fish and then allow the enzymes already present in the fish to liquefy the protein. When 3.5% formic acid is added to the fish the pH will be nearly 4. Mineral acids like sulphuric acid also can be used for this purpose. But in this case pH would be about 2.5, which requires neutralization before formulating feeds to the poultry or cattle. . There is an alternate method of production of silage by fermentation. The fish is mixed with a carbohydrate source like molasses and lactic acid is produced in the system to reduce the pH by introducing a lactic acid producing bacteria like Lactobacillus plantarium.

**Foliar spray**

Foliar spray is a technique of feeding plants by applying liquid fertilizer directly to their leaves by spraying. Plants are able to absorb essential elements and nutrients through their leaves and absorption takes place through the stomata of the leaves and also through the epidermis. Movement of elements is usually faster through the stomata and this result in faster growth and flowering. Some plants are also able to absorb nutrients through their bark. The process of foliar spray preparation is by hydrolysing the fishery waste either by adding acid directly as in case of silage or by in-situ production of lactic acid by microorganisms. The clear upper portion of acid silage is decanted and suitable diluted and used as spray. In case of microbial process, the fish waste is mixed with a carbohydrate source like molasses and inoculated with lactic acid producing bacteria and the lactic acid produced will hydrolyse the protein partially. It will take 20-30 days for hydrolysis and the upper clear liquid can be used as foliar spray.

**Feed**

Feed is the main input in fish culture and it accounts for about 50-60% of the variable costs of production. Among the commonly used feed ingredients, fish meal is considered to be the best ingredient, due to its compatibility with the protein requirement of fish. As it is the main expenditure in aquaculture, feed has to be given utmost care while preparation and storage. It has been reported that annual local market for commercial fish and shrimp feeds is around 35,000 and 30,000 metric tons respectively. The cost of feed production can be cut down by utilizing the waste generated from nearby fish markets. Studies conducted at CIFT has shown that feeds prepared from the cutting waste of different species have very good protein content and high nutritional status. No significant difference was noted in the growth rate of albino rats when fed with fish waste beed and whole fish meal based feed. Feed can be prepared by using fish meal as a base protein ingredients along with other carbohydrates like cereal flour, rice bran etc.  in a modified method developed at CIFT, the fish waste is initially macerated and calculated quantity of other ingredients are added and mixed thoroughly and the dough formed is steamed for sufficient period of time andmade into pellets mechanically. This process reduces the time required considerably and product will have higher nutritional value. The cost of production of ffed can be considerably reduced by this process.

Fishery waste which forms nearly 50% of the total weight of fish landed is an environmental issue in the present scenario. The recovery of biomolecules for the development of various products helps to eliminate harmful environmental aspects and improve quality in fish processing sector in addition to enhancing the profitability of the industry. However there are certain practical difficulties in the implementation of the strategies of utilisation. The problems in collection  and processing is hindered due to highly scattered nature of availability i.e., On board, Fish markets, Preprocessing centres and processing centres. Since the fresh water aquaculture is increasing every year the future utilization  and development of high value items from this sector has very high potential. Hence utilization of fishery waste for the development of high value products is gaining importance in recent years. A variety of by products can be developed which is found to have different applications in medical, food, and other fields. In fact the materials which caused problems to the fish processing industry due to the environmental pollution has become raw materials for valuable products with versatile application.

# Chapter 9

## Improved techniques for deep sea fishing

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India is having a coast line of 8,129 km spread across 9 maritime states and 2 union territories namely Lakshadweep and Andaman & Nicobar Islands are located in Arabian sea and Bay of Bengal respectively with 2.02 million sq. km as EEZ and 0.5 million sq. km as continental shelf. According to National Marine Fisheries census 2010, the marine fishermen population in India is estimated at 4.0 million, of which 0.99 million are active fishermen. Among active fishermen, 33% employed in the mechanized sector, 62% in the motorized sector and 5 % in the artisanal sector. In the marine fisheries sector, there are 37.3 % mechanized boats, 36.7 % motorized boats and 26.0 % non – motorized crafts.

With absolute rights on the EEZ, India has also acquired the responsibility to conserve, develop and optimally exploit the marine resources up to 200 nautical miles off our coastline (Planning Commission, 2007). The current exploitation from the marine capture sector is 3.81 million tonnes in 2017 as against the total projected potential of 4.41 million tones (2011 revalidation report, Dept. of AHDF). of which demersal is 2.13 million tons, Neritic pelagic is 2.07 million tons and Oceanic pelagic is 0.22 million tons.

Indian marine fishery harvesting mostly concentrate around coastal waters up to 100 meters depth and about 90 per cent of the catch comes from up to 50 m. A recent revalidation of marine fisheries potential has shown that the fishing pressure on the stock in near shore waters has gone up considerably and signs of over exploitation of species is becoming increasingly evident and further increase in effort in the coastal sector would be detrimental to sustainable yield. The impact of mechanized trawling and purse seining has also caused resource depletion. Sustainable resources exploitation from this sector is still possible through regulatory management strategies and concerted policy efforts for different species and for different regions.

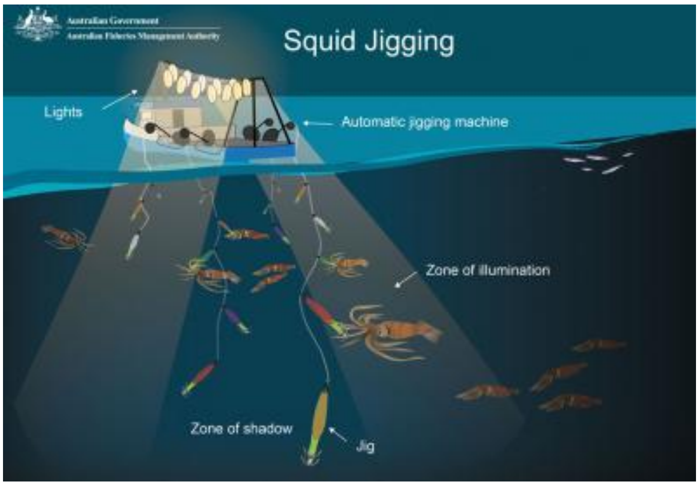
Deep sea fishery over the years has undergone several changes like modernization of fishing practices by including advanced acoustic equipments, navigational and emergency equipments along with diversification, intensification and extension of fishing to new ground which enhanced landing of targeted commercial species along with incidental by catch. Therefore, there is an urgent need for looking forward the unexploited or least exploited resources so as to meet demand towards the nutritional security of the country as a whole and for earning foreign money through export promotion. The fishing and allied activities provide employment opportunities for millions and it contribute 1.1 % of the total GDP of India. At this juncture, exploitation of under exploited non-conventional resources from the distant waters of the Indian EEZ is the only solution left with us. Moreover, there is an ample scope for increasing production by venturing into deeper waters of the EEZ, for underexploited and untapped resources and which can be achieved by operating the following resource specific and non specific fishing gears operations.

**SQUID JIGGING**

Squid jigging is a mechanical device used for catching squids by using coloured jigs and artificial lights. Both manually operated and automatic jigging machines are available for squid fishing. It consist of a drum where the line is spooled and the roller through which the line is released. The machine are provided with electric motor and line drums are fitted on both sides of motor. Jigs are spindle shaped coloured plastic lures with two rows of small sharp barbless hooks. Different colour like red, orange, green white, blue with a glowing appearance in water used as jigs.

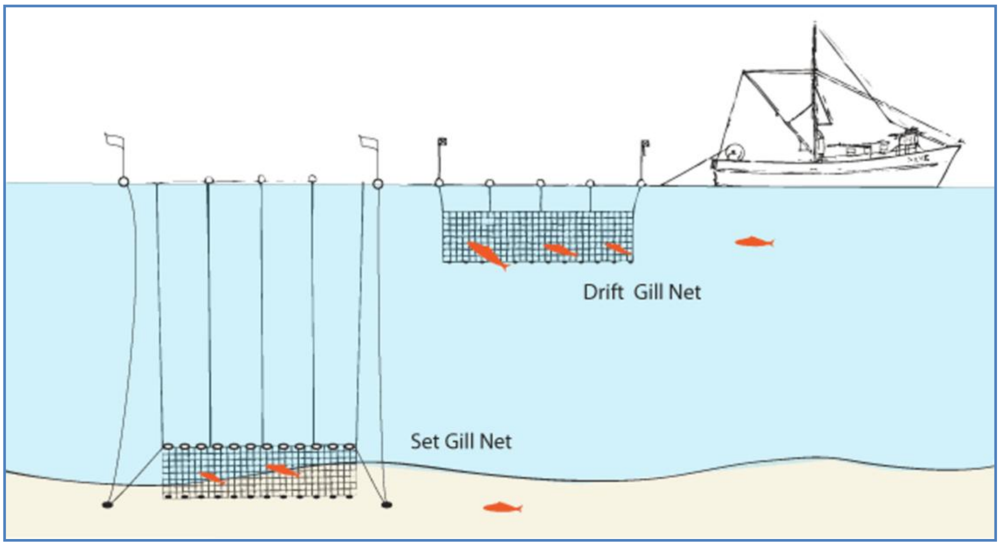
Luring lamps are important in squid fishing. As the squid are easily attracted towards the light. Luring lamp is normally used above the water level. But sometimes underwater luring lamps are also used to induce the squid shoal to come upto the surface.
Squid jigging accounts for nearly 40 per cent of the world cephalopod catches followed by trawling, which contributes 25 per cent of the catch. Gillnets are also used for catching the squids, which accounts for nearly 10 per cent of the catch. Gears like shore seines, boat seines, hooks and lines and spearing are the popular methods to catch cephalopods. Cephalopods are considered as an important source of marine fishery resource and many of the species are exploited as by catch by trawlers along the Indian coast and the fishery forms 4-5 per cent of the total marine fish. Arabian Sea is considered as one of the richest fishing regions for *Sthenoteuthis oualaniensis* (Mohamed, 2012). The preliminary studies on the oceanic squids in the Arabian sea indicated that thearea around Lakshadweep Islands is a major spawning grounds for oceanic squids(CMFRI, 2011). These species are known as the masters of the Arabian Seas due to its high abundance and large oceanic squids occupy and monopolise the trophic niche being apex predators in the Arabian Sea.

Fish aggregating devices (FADs) are traditionally used by the fishermen to attract and aggregate the species closer to the shore .Fishermen from Karnataka and Kerala started FAD assisted cephalopod fishery in coastal waters. However, It is indicated that the FAD assisted cephalopod fishery increases the vulnerability of spawners which may affect the conservation part of management measures. The introduction of high opening bottom trawl nets leads to an rapid increase in the cephalopod production from the Indian EEZ (Sundaram and Deshmukh, 2011).




**Gill Netting**

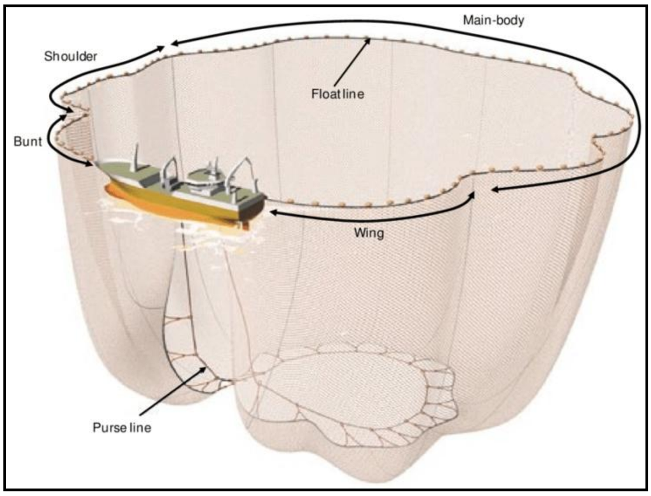
Gillnet is a large wall of netting which may be set at surface or below the water level or at the bottom or any depth in between surface and bottom according to the availability of resources. Probably the oldest form of net fishing having been in use for the last 1000 years. Fish are caught by gilling as they attempt to pass through the net. The gill nets are mainly used to catch the fish whose body size is almost uniform , since the mesh size must be matched to the fishes girth. This is one of the eco friendly and passive fishing gear which is used safely to catch resources without causing any damage to the ecosystem. It can be used as a small scale fishery and now it has been modernized by inducting equipments and machineries due to the immense pressure on capture fishery at deeper waters. Salmon cod Haddock, Pollock, barracuda Herring, Mullet, Rockfish, Sea bass, Shark, Sturgeon Swordfish, Tuna etc are caught by operating the gill nets.



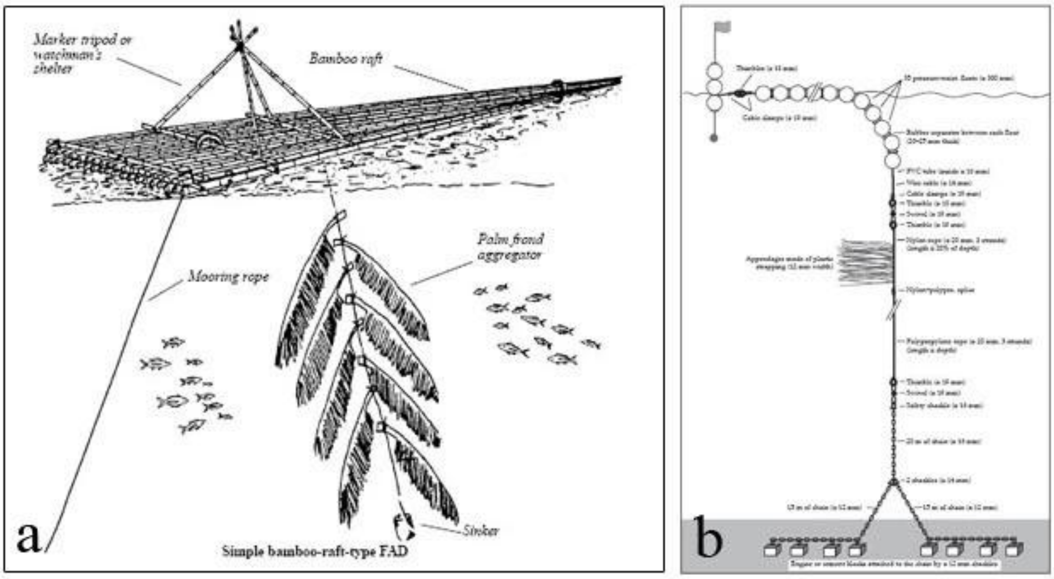

**Purse seining**

A purse seine is a large wall of netting deployed around an area with school of fish. The seine has floats along the top line and a lead line with sinkers. The purse rings are attached along the foot ropes through bridles. Once, a school of fish is located, the seiner encircles the school with the net. The lead line is then pulled in, and "pursing" the net, closed the bottom, preventing fish from escaping by swimming downward.

Purse seining is one of the most advanced and efficient commercial fishing method for capturing pelagic shoaling fishes like sardine , mackerel, Tunas etc. Purse seines are also used to catch the demersal fish such as cod by modifying its design to operate close to the bottom. It probably catch the higher percentage of total world fish landings than any other single fishing method. Advances in purse seining was supported by introduction of high tenacity synthetic fibers, improvement in vessel technology, gear handling equipments such as power block, fish aggregating techniques , fish detection devices such a sonar and remote sensing techniques.




Fish luring methods are used to concentrate fish for purse seining. This is a more effective method than chasing and surrounding methods. Fish aggregating devices (FADs) made of various materials used to concentrate the fish in south- East Asian countries. The FADs are fabricated by locally available materials such as coconut palm leaf ,coconut husk, Spadix ,nettings and used tyres. The fish start aggregating in about 1-2 weeks if the fish is abundant in that area. The FADs is equipped with selective call radio signals only on a pre fixed frequency and code which are picked up onboard direction finders to fix the position of FADs. This ensures secrecy of the location of FADs.



During night fishing, Powerful lights are arranged onboard a vessel or on the buoy to attract the fishes. When fishes are concentrated around and it is confirmed by acoustic methods, purse seining is carried out and captures the resources. However the light fishing is banned.

**Ring seine of Kerala**

Commercial purse seine fishing started during the late seventies in Cochin, Kerala. Subsequently process of motorization also started in eighties. Ring seine was introduced in mid eighties and it became widely adopted as one of the significant fishing methods in marine fishing sector of the state. The original ring seine was called as “Thangu vala” in Malayalam. However it differed from Purse seine in that it is smaller version with light webbing. Tapered towards wing on the ends and having 3 parts, a central bunt made of thicker twine and two end portions or wings.

**Trawl fishing**

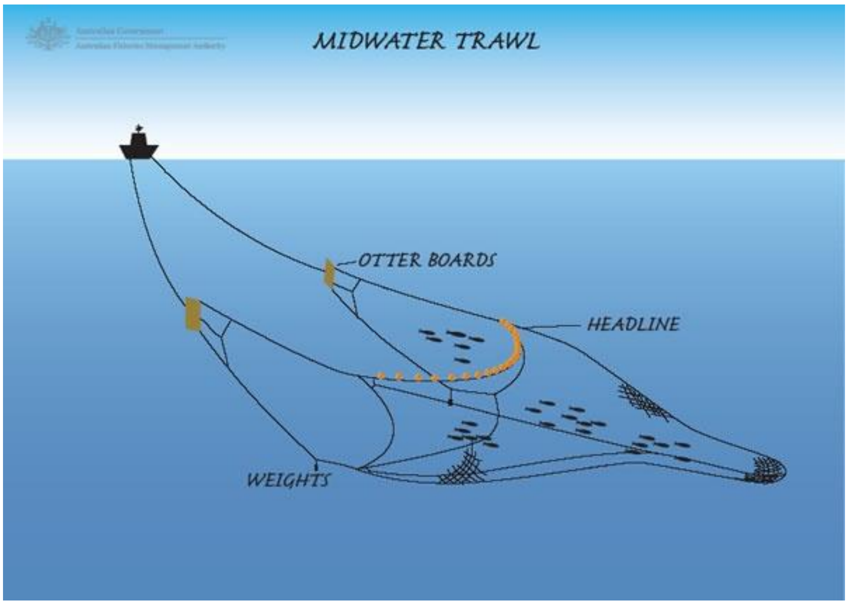
Trawl fishing is one of the important and intensive fishing operation in India which contribute the highest percentage of marine capture fishery. A large conical bag shaped net is dragged by one /two vessels by which an area under water is swept. It is operated at bottom or mid water column or sub surface pelagic area at the fishery resources as indicated by the Echo sounder/ SONAR. The bottom trawl fishing is a destructive fishing operation as it damages the habitat of bottom dwelling organisms. However, it is still contributing as the major fishery.

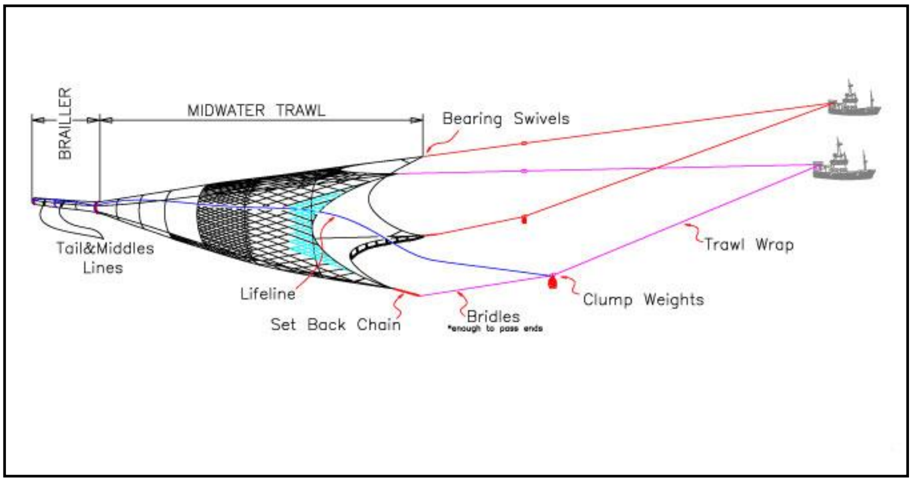
The Net sounder is an aid for trawl fishing. The knowledge of the position and state of trawl underwater contribute much for a successful fishing operation. This requires necessary sensors or transducers to be positioned on the Net and the receiver installed onboard the ship along with the link medium either by cable or by means of signals. The transducers give inputs regarding trawl opening both horizontal and vertical, vertical depth from the net to the sea bed and sea surface, water temperature , catch details, spreading of the otter board etc. The density of the fish population entering the trawl mouth is an indication of the catch details which is monitored by the sensors at the head rope.

The catch monitoring system is used with a variety of sensors. All these sensors are placed on the trawl at its cod end portion. The effects of currents can reduce the trawling yield. The sensors detect the currents and tides by which the traction speed can be adjusted and the yield is improved.

Aimed trawling requires the matching of vessels course and towing depth with that of particular shoal. The vessel searches for a fish shoal using a SONAR usually mounted towards the bow and which can be extended below the hull and rotated at 360$^o$ and can be tilted to search all around the vessel throughout the depth of the water column. Information showing the extend and density of fish shoal within the range is usually displayed on a colour monitor enabling the skipper to aim for an appropriate target and maneuver accordingly.

With the aid of net monitoring system skipper can then adjust warp length and speed to place the net at appropriate depth, and the course as necessary according to the information from the SONAR.

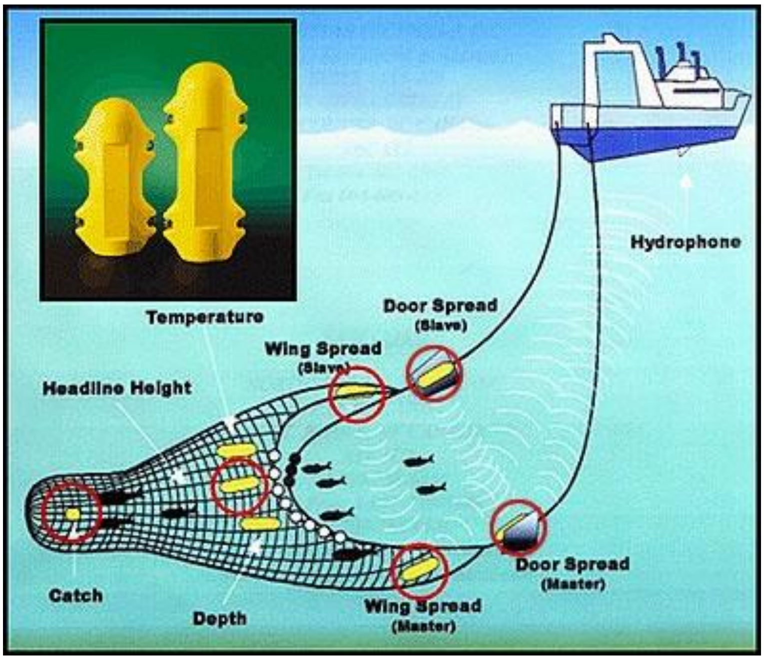



**Auto trawling**

The latest development integrates and coordinate information from the net monitor, fish finding, and position fixing with the ship's propulsion control system and auto pilot to provide computerized control of the fishing when the skipper has reached in

a fishing area and one or more fish shoals are located. He can shoot the gear and set up the automation system. The computer calculates  the probability of catching from each school and  if the skipper  decides to fish a particular school, he then pushes a button and computer takes over the entire operation.
The system determines the course and distance to the school, together with its depth , density of fish and indicates the time needed to reach it . Necessary course changes will be made with speed of vessel and warp length adjustment as necessary on the information of the shoal. If the school diverse, speed is reduced and more warp paid out to lower the trawl. The computer is continuously updated for shift in position of the school as well as the net behavior due to underwater current   and the operation continues until the net sensors indicates that net is completely dragged over the shoal and the entire fish is in the codend.  If a rock pinnacle or other sea bed obstruction is detected on the Echosounder, the net is automatically lifted above the obstruction before resuming fishing.




**Tuna long line**

Long line fishing for Tuna in high seas is a very popular technique employed all over the world. The gear consists of Main line, Branch line, hooks, float line, radio buoy, radar reflector, Flag buoys and other accessories.  For operational convenience and  easy handling, the gear is divided into units called "Baskets" and each baskets  consists of a main line , branch line with hooks and float line with floats. Generally a traditional Japanese multifilament long line  consists of five branch line  in a baskets. However, monofilament long line consists of 5 to10 branch line in a baskets. It is an efficient  and recommended fishing operation for harvesting targeted tunas and bill fishes and sharks as the bycatch. Specially designed long line  is operated for capturing Sharks.

However, oceanic skipjack tuna  is captured by purse seining and pole and line fishing in Lakshadweep islands. The automated shooting and hauling the line including baiting  are the advancements in long line fishing.  In modern large scale operations, main line is continuous  and stored in a main line storage tank or on a powered reel.

**Pole and Line Fishing.**

It is a traditional fishing for skipjack tuna in Lakshadweep Island, the union territory of India. It is an effective method for capturing the shoaling pelagic skipjack tuna. When the vessel approaches as near as the shoal, live baits are thrown out towards the shoal to attract the shoal of fish towards the boat. As soon as the fish come and concentrate near the vessel, chumming is increased. If the tuna react well, the engine is stopped. Simultaneously, water spraying is started on the sea surface through nozzle arranged along the fore and sides/stern of the vessel using pumps. When the fishes swims around the vessel, it is considered that they are fully attracted and the process of spraying continues so as to keep the fish in the vicinity of the vessel. Then the crew onboard put the barbless hook into the water and make a jerk and pull and bring the fish onboard. With another jerk the fish unhook on the deck.

# Chapter 10

## ICAR initiatives for Innovation and Entrepreneurship in Fisheries

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### Introduction

The Indian Council of Agricultural Research (ICAR) is an autonomous organisation under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. It is the apex body for co-ordinating, guiding and managing research and education in agriculture in the entire country. With 97 Research Institutes and 47 Agricultural Universities spread across the country this is one of the largest national agricultural systems in the world. With the aim of utilizing the vast research and development facilities and knowledge available with its institutions, ICAR has started a technology management and business incubation drive, designed for the Indian agricultural sector to promote agribusiness. This initiative started with the establishment of Agri-business incubation centres which effectively networked all ICAR research institutions for the management of new and cutting edge technologies developed by these institutions. ICAR started this move with the aim of improving its R&D system by incorporating new ways of doing business in agriculture and allied fields, to achieve the objectives of increased productivity, employment generation and strong national economic condition.

The Agri-Business Incubation (ABI) Centre and Zonal Technology Management Centre (ZTMC) established at ICAR-CIFT, Cochin supports operations on business projects as a measure of enhancing the foundation for new technology based industries and establishing a knowledge-based economy. It focuses on finding new ways of doing business in fisheries by finding doors to unexplored markets. ABI Centre helps prospective entrepreneurs, by providing pro-active and value-added business support in terms of technical consultancy, infrastructure facility, experts' guidance and training to develop technology based business ideas and establish sustainable enterprises. It acts as a platform for the speedy commercialization of the ICAR technologies, through an interfacing and networking mechanism between research institutions, industries and financial institutions. The Incubator at CIFT differs from traditional Business Incubators as it is tailored specifically for technology based industries and is operational at an area with a high concentration of fish production. This industry-specific incubator also allows new firms to tap into local knowledge and business networks that are already in place. ABIoffers its services to industries not only in Cochin, but also all over India through virtual incubation. Beyond promoting business growth, the Centre aims to bring its benefits to all the fisheries communities in India.

### Protection and management of intellectual assets of ICAR

Agricultural science has been the engine of economic growth and has led to quantum jumps in productivity in the past. Application of ICAR technologies in farmers' fields and backyards has increased agricultural output and farm incomes. These technology packages have been the major contributors to the green, white and blue revolutions that brought out spectacular gains in Indian agriculture. The technological assets of ICAR include a number of high yielding and resilient crop varieties, animal and poultry breeds, packages of improved crop and animal husbandry practices, natural resource management technologies, improved tools, equipment and farm machinery, animal science and fisheries technologies, harvest and post-harvest technologies, computer software and datasets, and several other processes and products of agriculture and allied sectors. ICAR focuses on producing significant research output to enable further enhancement of agricultural productivity and help meet the future needs.

**Role of Zonal Technology Management Centre**

The IP and technology management drive of ICAR has entrusted the ZTMCs of different zones to establish a mechanism that accedes to the conditions of international standards and also to find ways for stimulating research, enabling access to technology and promoting enterprise growth, all for the ultimate benefit of the Indian farming community.

The main activities of ZTMC is targeted at the development and use of a Database System for management of intellectual assets, IPR protection, sensitization and capacity building, development of technology evaluation tools, formulation of model Business Plans/Project Reports and technology transfer/commercialization through business incubation. The Centre aims at protecting and translating the research results arising from the field of fisheries and other agricultural sectors into successful business ventures. It identifies new opportunities of business formation and helps the prospective entrepreneurs, by providing pro-active and value-added support in terms of technical consultancy, IP protection, infrastructure facility, business support services and training to develop technology based business enterprises.

ZTMC guides the member institutes under the zone to secure IPR protection of the research results, as per the Indian law and in conformity with the international agreements to which India is a signatory. It promotes transfer of these IPR enabled technologies, including finished processes, products, creations / works and other know-how, through commercial and public routes to farmers. The systematic management of IP assets have promoted commercial ethos in public sector research helping to transform agriculture from a predominantly subsistence mode to a globally competitive one. The Unit have the powers and flexibility to outsource for efficient execution of IP and commercialization matters.

**Strategies adopted for Technology Management**

***Sensitization and capacity building***

ZTMC regularly conducts Workshops, Meetings and Seminars with the participation of all ITMUs for awareness creation, faster adoption and implementation of the new scheme of Intellectual Property Management and Technology Transfer/Commercialization within ICAR. This has helped in chalking out the best-fit strategies and work plan for IP management by inculcating business ethos in transfer of both proprietary and public domain technologies. The scientific community was trained in handling technical information, finding solutions to technical problems, acquiring rights in public domain, identifying patentability potential of technologies at early stages of development, avoiding risk of R&D duplication and solving potential disputes involving patents.The member institutes were given clear guidelines to convert their innovative ideas into business activities, to evaluate the commercial and economic viability of an invention, to formulate business plans and R&D contracts, to market and commercialize the invention, and to find potential business partners. Disputable areas regarding ownership of patents, acquiring trademarks in the name of the institutes, acknowledging the parent institution while selling the technologies etc. were sorted out during such meetings.

***Collaboration with member institutes under the Zone***

Under ICAR there are two statutory monthly reporting activities; one is summary highlights of research findings to be submitted to the Prime Minister's Office and two is input for the report for the Result Frame Document (RFD) of ICAR for information of Performance Monitoring and Evaluation Division of the Cabinet Secretariat. The IP protection and technology transfer/commercialization activities of the ITMUs are continuously monitored by the ZTMC, for compilation and onward transfer to ICAR. A comprehensive assessment system was devised for research and technological affairs at the zonal level for improving the supervision of research programs and activities for aiding ICAR in decision-makings and supervision processes. The ZTMC summarizes and reports the most important results that the member institutes have achieved during the period like product / process developed / commercialized, partnership development, including licensing of ICAR technologies and IPR titles.

***Guidelines for IP Exploitation***

In order to ensure that, R&D Institutes under ICAR captures and harness the value of its intellectual property (IP), and to also encourage the development, protection and commercialisation of research results arising from its research activities across all agricultural disciplines, specific IP management guidelines have been formulated. As a publicly funded institution, ICAR is under an obligation to ensure that the research outputs are used for public benefit. It recognises the importance of generating intellectual property and obtaining IP rights to optimise the use of research outputs for public and commercial benefit.The main aims of theseguideline are to:

- inform members of the ICAR community of their rights and obligations relating to IP created in the course of undertaking R&D activities
- recognise the creative contribution of staff
- provide an appropriate incentive structure to reward innovators for successfully commercialised IP
- protect the interests of the ICAR and all its members
- recognise and promote the benefits of open access to knowledge and its public dissemination, while balancing this with the need to protect commercially valuable outputs of research activity

IP that is potentially exploitable will be identified and recorded using the IP Disclosure Record. The Institute management should strictly ensure the unprompted disclosures from staff and research students. In doing so, all parties will be cognisant of not damaging the Institute's core research and development activities. All identified IP will be reviewed by the ZTMC, to consider its suitability and marketability. The Panel will take into account the wider strategies and policies of the Institute in determining the exploitation route. Protection of the IP will be determined and funded by the ZTMC.The Institute may make use of specialist external organisations, to take forward specific cases, where they bring detailed knowledge of the technology and/or relevant market. Interactions with such organisations will be managed by ZTMC. The timescale for exploitation of any given set of IP depends significantly on market conditions as well as the state of development of the IP. The discussions between ZTMC and creator(s) / innovator(s) includes agreement of a reasonable initial timetable, with regular review points. All parties involved have responsibilities in achieving successful exploitation, and need to be aware that circumstances will change as the process develops. Where an innovator is to undertake an involvement with a licensee or other external organisations, it must be governed by a suitable agreement between the company and the Institute, e.g. for consultancy, services etc

**Business Incubation Centre at CIFT**

Fisheries sector with its important role played in the socio-economic development of the country has become a powerful income and employment generator, and stimulates the growth of a number of subsidiary small, medium and large scale industries. In order to translate the research results arising from the field of fisheries and other agricultural sectors, and to establish fisheries enterprises through IPR enabled technologies, ICAR set up an innovation based Agri-Business Incubation (ABI) Centre at ICAR - CIFT, Cochin. ABI supports operations on business projects as a measure of enhancing the foundation for new technology based industries and establishing a knowledge-based economy. It focuses on finding new ways of doing business in fisheries and allied agricultural fields by finding doors to unexplored markets. The Centre helps prospective entrepreneurs, by providing pro-active and value-added business support in terms of technical consultancy, infrastructure facility, experts' guidance and training to develop technology based business ideas and establish sustainable enterprises. It acts as a platform for the speedy commercialization of the ICAR technologies, through an interfacing and networking mechanism between research institutions, industries and financial institutions. The Incubator at CIFT differs from traditional Business Incubators as it is tailored specifically for technology based industries and is operational at an area with a high concentration of fish production. This industry-specific incubator also allows new firms to tap into local knowledge and business networks that are already in place. ABI offers their services to industries not only in Cochin, but also all over India through virtual incubation. Beyond promoting business growth, the Centre is also trying to bring its benefits to all the fisheries communities in India.

With the aim of transforming the incubator into a symbol of entrepreneurship and innovation, the ABI has created an environment for providing timely scientific and technical assistance and support required for establishment of technology based business ventures. The activities of the ABI focuses on finding creative and innovative ways for linking public sector resources and private sector initiatives within and across regional and national boundaries for promoting economic growth. The Centre uses the right expertise in relevant fields to identify and analyze the constraints and barriers hindering the growth of a business and devise appropriate strategies. It explores various structures and strategies to help small enterprises to grow and ensure a promising future in the global market. It fosters corporate and community collaborative efforts, while nurturing positive government-research-business relationships.

***Process of Business Incubation***

The Agi-Business Incubation (ABI) Centre targets entrepreneurs, from fledgling start-ups in need of basic small scale processing capacity to sophisticated businesses in need of R&D back up, office infrastructure and pilot / test market processing facility for the development of new products. It possesses good infrastructure facilities suitable for providing direct incubation to 9 entrepreneurs in a corporate environment within the premises of CIFT at a time. The purpose of direct incubation is to support emerging companies through their infancy. ABIapart from being a multi-tenant facility with on-site management that delivers an array of entrepreneurial services to clients operating with the facility, it also serves clients that are not located in the facility through virtual incubation or incubation without walls.

The Centre regularly conducts industry interface and technology promotional programmes for sensitization of entrepreneurs and to identify interested potential candidates for physical and virtual incubation. The Clients at ABIgets the privilege of meeting ICAR-CIFT officials directly, to discuss and finalise the strategies to be adopted to take the business forward. It is also the peer-to-peer relationships that develop within the incubator, that ensures the delivery of basic services such as how to actually incorporate a business; what are the legal issues; how to take intellectual property protection; how to do basic accounting and cash flow; how to do business presentations etc. Those kinds of skills are what are transmitted as part of the incubation process.

***Client Selection***

The process of client selection starts with the review of applications submitted by the Entrepreneur for becoming Business Incubator Client. The application must address the requirements described a prescribed format which includes executive summary, vision and focus, financial plan and economic impact of the proposed business. The application and the proposal will be first reviewed by the Principal Investigator of the Business Incubation Centre against the set criteria. During the second stage of the selection process, applications will be evaluated by a Joint Evaluation Committee. The committee reserves the right to request additional information from an applicant, or reject / accept an application. During the committee’s review, applicants will be required to make presentations of their proposals. Once selection procedures are completed, the Client can sign Memorandum of Understanding with CIFT, for availing the facilities and services of ABIfor a limited period of time on a payment basis.

The residency period for direct incubatees is normally for oneyears, extendable by another year in special cases, depending on the progress of business development. As the business venture becomes mature enough, the concessions and the facilities provided to the incubatee companies will be gradually withdrawn. Incubatee mentoring will continue in virtual mode after graduation on a case to case basis.

***Services and facilities offered***

The Incubation Centre provides shared physical workspace, management and technical assistance, access to financing and other supporting services to the incubating entrepreneurial firms.

Incubation facilities under one roof are,

- Furnished office suites within the premises of CIFT, with shared facilities like secretarial assistance, computing, copying, conferencing, video conferencing, broadband internet and communication services.
- Pilot level production lines
- Culinary facility
- Modern laboratory facilities for product testing and quality control
- Physical and digital libraries

***Pilot Level Production Lines***

A state-of-the-art generic semi-commercial production facility is made available to incubating entrepreneurs for developing value added products from fish. ABIprovides access to these facilities along with support of manpower, and assists the entrepreneurs in production and testing of new product formulations. The plant also serves as a process lab.

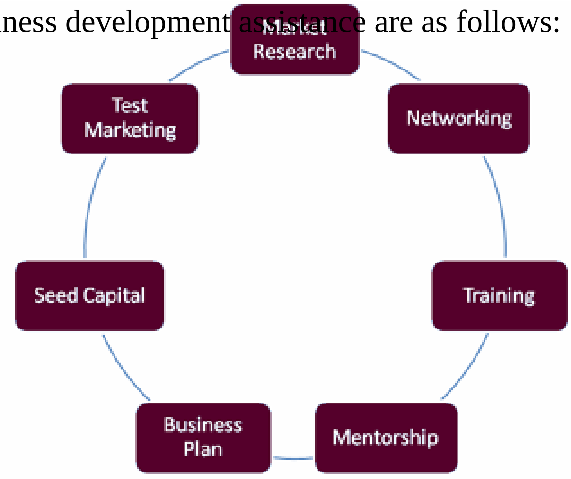
Various lines available with ABIfor entrepreneurs are listed below:

- Fish Pre-Processing line
- Retort Pouch Processing unit
- Fish Canning line
- Fish Sausage production line
- Fish extruded product line
- Fish Curing and Drying line
- Fish battering and breading line
- Fish product packing system line
- Chitin & Chitosan Production line

The Centre greatly reduces the high capital cost faced by small entrepreuners.

***Business Services***

The business oriented services offered by ABIinclude assistance in complying with business regulations, licensing procedures, financing, information services, marketing and tailor-made services designed for the various tenant enterprises. Incubator clients can also gain special advantage in terms of tax savings through special regulations for Business Incubators. ABIalso offers a wide variety of services, with the help of strong associations throughout the Business Incubation Network. Currently the services being offered as part of business development assistance are as follows:



***Facilitation for financial assistance***

The ZTMC facilitates the availability of loans with the aid of State Bank of India (SBI), Agri-Commercial Wing and provides direct access to financial schemes offered by Micro Small and Medium Entreprises (MSME) for gathering capital investment, company expansion and new product development. It also helps entrepreneurs in developing linkages with various venture funding agencies. ABIbeing a registered member of Indian STEP and Business Incubators Association (ISBA), the privileged tenants of incubator are entitled for getting tax exemption benefits as well as opportunity to attend the ISBA Annual conference, workshops, training programs etc.

***Promotion of ICAR Technologies***

The ZTMC, since its establishment at CIFT, has been responsive to the rapid transformation of innovation processes and business needs, and has been continuously trying to enhance the visibility of ICAR technologies through Business/ Industry Meets, Exhibitions, Industry Interface Programmes etc. This has helped in strengthening the public private partnerships and to bring together innovators involved in research and development, and entrepreneurs from the field of fisheries on to the same platform. Technology exhibitions are regularly organized, and entrepreneur-ready innovations and technologies developed by the ICAR Institutes specialized in fisheries and aquaculture are exhibited to the Industry. The areas addressed are seed production technologies of fish and shrimp, cost-effective and nutritious fish feed formulations, diagnostic and test kits, new and improved aquaculture methods, harvest and post harvest technologies, ready-to-cook / ready-to-serve products from fish, pharmaceutical and biotechnological products, and techniques for fisheries waste management.

***Human Resource Development***

Human resource development for the fisheries industry has been in the mandate of CIFT since its inception. Fish processing industry is a fast growing industry in our country as well as abroad, where there are immense opportunities for rightly trained professionals. CIFT has the right expertise and facilities to provide hands-on, application-based training courses such as HACCP concepts, HACCP Audit, Seafood Quality Assurance, Basic Food Hygiene, Food Processing and Preservation, Energy Efficient Harvesting Techniques, Boat Construction etc. Successful trainees have high potential for employment in India and various foreign countries including Middle East and South Africa. The ZTMC organises several awareness workshops, seminars, training programmes etc. for human resource development in the fisheries sector. The Unit also conducts capacity building programmes to help the incubatees build their competence in the areas of business practices, technology up scaling, networking and financing strategies.

**OUTCOMES**

- Transmitting benefits of developed technologies to the nation fast and effectively
- Distributed regional economic growth and national wealth creation through SMEs
- Creation of gender equity and economic independence to women through SHG clustering
- Reduced chances of failure for first generation entrepreneurs and consequent saving of national wealth

- Import reduction and enhanced national life style through introduction of innovative products and services
- Increased national savings through efficiency enhancement of industries
- Employment generation
- Enhanced build-up of human resources and national IPRs
- Encourage thrust towards solution driven research to benefit target groups
- Increased revenue to host Institute

## LESSONS LEARNED IN BUSINESS INCUBATION AND WAY FORWARD

From the experience gained from the interaction with budding entrepreneurs, three primary reasons which create difficulty to the small and medium start-up businesses to remain competent have been identified. They are, lack of access to capital, lack of managerial skills, and the lack of knowledge about how to estimate their markets, gauge growth and potential business basics. Incubators are proved tools that can specifically address these three issues. High risk start-ups are instrumental in creating jobs, and business incubators play a role in making and leveraging the investments these entrepreneurs make. In a country like India, entrepreneurship is ubiquitous and is reflected in all the major dimensions of civilization *viz*. social, political and economic. With the initiation of economic reforms in early 1990s, India's business environment has witnessed considerable improvement. Domestic and foreign investors are finding it easier to do business after the reforms, which are aimed at reorientation of the centrally controlled economy to a market-oriented one in order to foster greater efficiency and growth. In spite of the global meltdown, Indian economy offers ample opportunities for business, both to the domestic and foreign entrepreneurs.

## CONCLUSION

Amidst the changing paradigms and demanding global structure, India, in order to remain a frontrunner among developing nations, has primarily focused on the agriculture sector. The scope and level of protection of intellectual property rights (IPRs) has been increasing in the past few decades. The three tier IP management system is introduced in ICAR as an incentive for investing in research and development, creative activities, and for extending markets for technology and products. Among the various strategies to promote planned growth in this sector, focus was also given on promoting viable small and medium scale enterprises. However the Indian agricultural sector, despite its importance in industrialization strategy and immense potential for employment generation, confronts several problems in business development and management. In this context, business incubators which can help entrepreneurs turn their ideas into viable businesses and promote innovation, by providing business support services and resources have great scope and significance.

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## Chapter 11

### Plant Inspection and Approval

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**Introduction:**

Export Inspection Council is the Regulatory Authority operating under the Ministry of Commerce & Industry, Govt of India. The Official Export Inspection & Certification Body of India established in 1964 by Govt. of India under section 3 of Export (Quality Control & Inspection) Act, 1963.Objective is to ensure sound development of export trade of India through quality control and pre shipment inspection. Export Inspection Agency, the field offices of EIC does the official controls having its state of art laboratories for testing microbiological and chemical parameters.

The requirements for the approval of the establishments to process or to undertake allied activities related to fish & fishery products meant for export have been published vide GOI Order 729 (E) dated 21.8.1995, subsequently amended vide Orders S.O. 792 (E) dated 17.8.2001, S.O.722 (E) dated 10.7.2002, S.O. 464 (E) dated 24.4.2003, S.O. 1227 (E) dated 23.10.2003 and 1227 (E) dated 31st July 2006 and GOI Notification S.O. 730 (E) dated 21.8.1995, subsequently amended vide Notifications S.O 415 (E) dated 11.4.2002, S.O 1029 (E) dated 24.9.2002, S.O.1034 (E) dated 9.9.2003, and S.O.717 dated 25.2.2005, S.O. 612 dated 15.2.2007, S.O.1519 (E) dated 16.6.2008, S.O.2714 (E) dated 28.10,2009, S.O. 143 (E) dated 21.1.2011 and S.O. 497 (E) dated 10.3.2011 on the basis of which the facilities related to fish & fishery products meant for export are being approved by the Competent Authority (EIC/EIA).

The Primary responsibility for meeting the health requirements of importing countries and also those specified in the GOI Notifications lies with the facilities, for which they are required to plan and implement detailed HACCP based process control (own check system), where needed, and to maintain necessary records. The role of Export Inspection Council (EIC) and Export Inspection Agencies (EIAs) is to exercise Official Control by approving these facilities and implementing an effective surveillance system to ensure compliance to the requirements as per Rule 3 read with Rule 13 of the Notification No. S.O. 730 (E) dated 21 August 1995.

Facilities intending to get involved in the activities related to the export of the fish & fishery products are to be approved by EIC / EIAs based on their compliance to the requirements of GOI Notification S.O. 730 (E) dated 21.8.1995, as amended from time to time, statutory requirements and those specified by the importing country.

**Approval of establishment under FSMS:**

The establishments intending to process or to carry out allied activities for export of fish and fishery products shall submit an application for approval in the prescribed format to the nearest office of EIA under whose jurisdiction the operational base of the applicant is situated.

The application shall be accompanied by the following documents based on requirement:

- ✓ Application as per prescribed format
- ✓ HACCP manual & Plant layout
- ✓ Water/ice test report
- ✓ Legal Identity & Lease agreement
- ✓ Registration certificate by registering authority
- ✓ Technologists
- ✓ Undertaking & guarantee as per prescribed format
- ✓ Consent to operate issued by state PCB
- ✓ IEC number

The assessment Panel of Experts (APE) comprise representatives from different departments assess the establishment in two stages. The Convener of the APE shall be an EIA representative. The quorum of APE shall be two. However, it must be ensured that the APE has appropriate experts to carryout an objective assessment of the facility

In the first on-site visit, the APE shall assess the infrastructure and equipment facilities and also their compliance to regulatory requirements specified in the GOI Notification / Executive Instructions and if satisfied, recommends for the conditional approval.

Once conditionally approved, the facility shall be allowed to start processing of fish and fishery products (F&FP) or carry out related activities however export is not allowed till full approval.

The conditionally approved processor shall intimate the Agency as soon as production has started. While the processing activities are in progress, the APE shall make its second visit to the facility to assess the processing methods adopted by the unit and also to conduct HACCP audit. Based on the satisfactory assessment report of the APE, the full approval is granted to the facility by the Competent Authority.

2$^{nd}$ APE visit is carried out to verify the implementation of HACCP as per the scope of approval and they verify followings:

- HACCP Team:
- Composition/product description: Physical, chemical and microbiological characteristics of the product(s)
- Shelf life, method of preservation, Treatments, Method of packing, regulatory requirements, Conditions of storage and distribution, Microbiological and chemical criteria.
- Intended Use
- Process flow diagram and layout plan(e.g. Separation of clean and dirty areas )
- Hazard Analysis.
- Identification of Critical Control Points (CCPs).
- Critical Limits in line with the regulations
- Monitoring Procedures

- Corrective Actions
- Verification of HACCP System
- Record Keeping System

**Official Control**

- Strict confidentiality are maintained for the visits
- The visits are conducted unforeseen and unexpected.
- Three-tier surveillance system for proper official control ( MV/SV/Corporate Audit)

<u>Purpose of visits:</u>

- ✓ Approved facilities are being maintained.
- ✓ All the regulatory requirements and those specified by the importing countries are being complied with.
- ✓ Products processed conform to specification.

<u>Area of Monitoring</u>

- ✓ **Facility checks(**facilities are being maintained or not).
- ✓ **Verification of HACCP Implementation (**CCP, GMP, SOP, SSOP, traceability, T/T, controls on additives/ preservatives, quality management of water and ice, calibration and validation, special requirements for cultured shrimps or not)
- ✓ **Verification of testing and lab practices (**sampling and test methods are <u>adequate & reliable</u> or not)
- ✓ **Verification of records (**records are in order and are addressing all the controls exercised by the unit or not. Export documents- random check)
- ✓ **Fraud control** (Un-authorized production, improper labelling, exceeding production capacity etc)
- ✓ **Drawal of samples (**Organoleptic, micro, chem, water, ice, swabs)

**General Requirements for Approval of Establishments for Processing Fishery Products for Export**

<u>Surroundings</u>

- Clean & defined cartilage.
- Concreted Roads in the premises.
- No swamps, stagnant water or signs of any rodent harbourage.
- Free from objectionable odours, smokes & dust.
- The immediate surroundings of the building shall be tarred / concreted.
- Building of permanent nature.
- Products handling areas shall be separate from areas used for residential purpose.
- Non–operative areas inside the establishment shall be properly cordoned off

<u>Plant facilities</u>

- Store room for inedible material, disinfectants and insecticides
- Storage of wet and dry items
- Storing packaging material
- Rest Room for workers
- Changing room for male & female workers
- Water treatment plant

- Alarm system in case of power failure
- Generator

Sufficient No. of toilets

Raw Material Receiving Section

- Raised platform with sides and top of it shall be sufficiently protected
- RM receiving section shall be sufficiently separated from processing area to prevent contamination.
- Air curtain or any other device at the chute to prevent the entry of flies when the door is opened and fly killers at strategic points to trap the insects.

Fig: 01-Raw material receiving platform

Change Rooms

- Adequate size, smooth washable walls and floors
- Flush lavatory and shall not open directly to the working area.
- The toilets shall have self-closing doors and fly proof.
- Non-hand operable washbasins with liquid soap, nail brushes and single use paper towels.
- Non-hand operable waste bin to collect used disposable towels.
- Facility for keeping gumboots, street chapels, lockable cupboards, working clothes etc

Workers Entry Points

- Air curtain at all entry points
- Suitable washing and sanitizing facilities for feet and hands
- Foot or non-hand operated taps for hand washing
- Liquid soap, disinfectant, nail brushes, single use towels
- Foot-operated bins for collecting used towels.
- Fly killer
- Signboards directing to wash & sanitise the hand & foot.


Fig: 02- Hand wash area at the entrance

Ceiling, Walls and Floors

- Floor: smooth, impermeable, easy to clean, No water stagnation, slope opposite to the flow of work or sideways
- Walls: Durable, smooth, light coloured, easy to clean, wall to floor and wall-to-wall junctions shall be rounded off should not have projections.
- Ceiling: Free from cracks, open joints and smooth and easy to clean, if structural elements or fittings are suspended below the ceiling, suitable protection shall be given to prevent falling of debris, dust or droppings

Doors, Windows And Ventilators

- Doors: Tight fitting, durable, corrosion resistant, self closing.
- Windows and ventilators: fly proofing nets, windowsills, if any, shall slope inwards, shall be constructed at least one meter above the floor.
  Mechanical ventilation / exhaust fans shall be provided in areas were stagnation of air, condensation of fluid etc. are present.
  The opening of ventilation / exhaust fan shall be provided with fly proofing system

Fig: 03-Windows and ventilators

Drainage

- Adequate size and slope.
- Open end shall be protected against the entry of rodents.

Opposite to the flow of product.

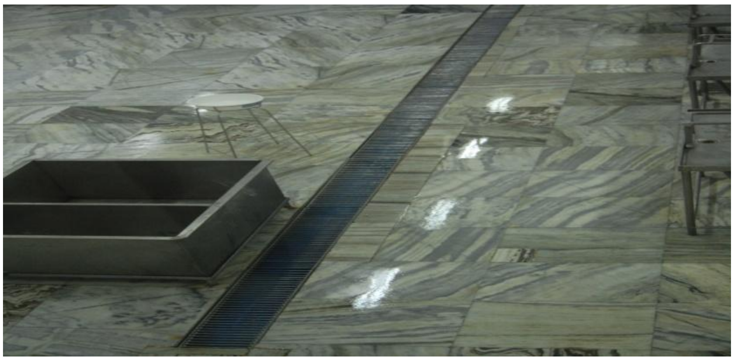

Fig: 04-Drainage

Tables, Utensils, Equipment And Machineries

- Non-corrodible material
- Smooth without cracks, crevices and easy to clean.
- Free from rust and paints.
- Suitable arrangements shall be made to drain the water from the tables directly into the drainage without falling on the floor.
- Machinery shall be able to provide desired temperature within the stipulated time, fitted with necessary gauges to indicate the temperature, pressure etc.

The temperature reading and recording devices shall be calibrated at specified intervals

Chill Rooms

- To maintain temperature at the level 0°C to 4°C.
- Must be in the pre-processing and processing both.(for EU)

- For non-EU establishment, adequate number of insulated boxes may be permitted in place of chill rooms.

There shall be a cleaning schedule and rodent control system

Cold storage

- To maintain the product temperature at -18°C or below.
- The floor, ceiling and walls shall be smooth and easy to clean
- Adequate lighting with protective covers.
- Wood shall not be used in the anterooms.
- Automatic temperature recording device and shall comply with EN 12830, EN 13485 and EN 13486.
- Air curtains / blinds shall be at the entry of the cold storage
- Air curtains shall be at the entrance to the anteroom
- The loading bays shall have suitable mechanism to prevent the entry of flies into the anteroom.
- Alarm system in the cold storage.

Chemical store

- Separate stores for wet and dry items
- properly labelled with suitable language.

Packing material store

- Packing material store shall be of adequate size with proper fly and dust proofing system.
- Cartons shall be kept on cleanable pallets other than wood, away *from* the walls and covered properly.
- Enough space for a person to walk around.
- Shall have pest and rodent control measures.

Water

- Requirements as per 98/83/EC or as per IS : 4251 (except radiological factors)
- Potable water shall be used for cleaning utensils, tables
- Suitable water management system.
- Plumbing diagrams with serially numbered taps.
- Water store tanks with effective locking arrangement and cleaned regularly.
- The taps having hose connections shall be fitted with non- return valves to prevent back suction.

Ice should be made of potable water and shall be adequate quantity.

Fig: 05-Water treatment area

Personal Hygiene

- Clean work dress and headgears, free from communicable diseases, open sores and wounds
- One person shall be made responsible to supervise this.
- Registered medical officer certify that "fit to handle food products and suitable to work in fish processing plant" in the health cards.
- Prophylactic injections shall be administered to the employees and record maintained thereof.
- The workers shall be medically examined after each absence due to illness.

In-house laboratory

- Well-equipped for testing microbiological and other chemical parameters.
- The testing shall be done by a qualified technologist (s) approved by the Competent Authority.
- If in-house lab is not available, then establishments shall test own check samples at EIA labs( or EIC approved labs for parameters that cannot be tested in EIA lab.
- In-house ELISA is mandatory for processing of aquaculture shrimps.

Transport

- Suitable and adequate facilities for the transportation of raw material, finished products etc.
- The food contact surfaces of the vehicles shall be smooth made of non-corrosive material and easy to clean and disinfect.

Vehicles shall be cleaned and disinfected before loading and after unloading and maintained records thereof.

Effluent Treatment

- Efficient effluent treatment system

Consent to establish/ consent to operate from state PCB

Fig: 06-Effluent treatment area

Rodent/Vermin Control

- documented procedure for vermin control
- Responsibility has been fixed for this work
- Own arrangement or through outside agency
- Bait map showing serially numbered bait stations
- Chemical/ rodenticide, if used it must be approved by the competent authority

**GENERAL REQUIRMENTS**

HACCP manual

The HACCP Manual shall address the processing activity and have the flow chart for each and every product

*Traceability*

Traceability of all the raw materials and additives/ingredients used for processing shall be maintained properly.

Residue Monitoring

The establishment should have a residue monitoring plan to control the residual contamination for each raw material used for processing .Approved suppliers list, approved farm\fishing vessel list should be maintained. Plan for farm\vessel audit should be maintained.

Records

All the relevant records required for the processing the product(s) are to be maintained by the unit for verification

Quality Control and Inspection

Inspection and testing shall be conducted by the unit at all stages to ensure that the product conforms to the specification.

In-house ELISA lab

*The establishment packing aquaculture products should have In-house ELISA facility for* *testing of CAP,NF Metabolites at RM receiving stage\Pre Harvest as declared by establishment in HACCP*

Records

Proper records at all stages (production, storage & transportation) shall be maintained and shall be made available for verification by EIA.

- Traceability records (RM, chemical and frozen products)
- Raw material receiving and evaluation records
- CDPR (Consolidated daily production register)
- Freezing & packing records
- Temperature, Organoleptic, Microbiological, Chemical reports
- CCP monitoring records
- Corrective action, verification, Calibration records
- Pest control, Cleaning and sanitation records(covering all areas)
- Maintenance records , Training records
- Internal audit records , HACCP review records
- Personal Hygiene records, Health cards
- Shipment/Despatch register
- All Input and output records

# Chapter 12

## Certification and standard implementation in marine product export trade

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**Introduction**.

India a major exporter of marine products. Major importing countries are US, EU, Japan, China. There are 8 categories of marine products such as

1. Frozen marine products.
2. Canned marine products
3. Freeze dried marine products
4. Live marine products other than ornamental fishes
5. Dried marine products
6. Ornamental fish
7. Fresh/ chilled marine products
8. Others ( edible/non edible).

**Certification**

Procedure by which official certification bodies or officially recognized certification bodies provide written or equivalent assurance that foods or food control systems conform to requirements. Certification may include continuous on-line inspection, quality assurance system auditing and examination of finished products.

**Types of certification.**

1.*First party certification*: self-declaration of conformity with self-set standards by the company making the claim;

2.*Second party certification*: verification through an affiliated body, e.g. an industry/trade/consumer association; usually against standards established by these bodies.

3.*Third party certification*: conformity assessment and audit by an independent inspection body/ individual.

**Advantages of third party certification:**

1. Increased market access,
2. Competitive advantage,
3. National and international acceptance,
4. Reduced risks and liability,
5. Greater confidence in regulatory compliance,
6. Reduced costs and improved profitability.
7. Categories of certification schemes.

**A.Government initiated certification schemes**.

These are mandatory in nature and covers product and/or process.They are food safety certification and legality certification.

**1.Food safety certification;**

It is mandatory and covers both process and product.either single attribute or multiple attributes. Certification may be first,Second or third. Main addressees are B2B and consumers.Agency responsible is Export Inspection Council (EIC) of India and Export Inspection Agencies (EIAs). EIA has 5 offices in Chennai, Delhi, Kochi, Kolkata and Mumbai.In India there was no certification for export in the beginning. Introduced well defined export control system in 1963. Established the Export (Quality Control and Inspection) Act 1963. Initially only voluntary inspection and certification was done.But later compulsory pre-shipment was introduced.

End-product inspection was replaced by In-Process Quality Control where some controls were exercised during production , handling and storage. Subsequently replaced by a better system called Modified In-Process Quality Control (MIPQC). Qualified technologists and a well equipped laboratory were made mandatory. Owing to pressures from importing countries government of India through Order No.S.O 729(E) and 730(E) dated 21/08/1995 made HACCP based quality assurance mandatory in seafood industry under Export of Fresh, Frozen and Processed Fish and Fishery Products ( Quality Control, Inspection and Monitoring) Rules 1995. The system is called Quality Control In Approved units (QCIA).

Certifications by EIA/EIC includes **Certificate of Export (CE**); **Health Certificate** for fishery products intended for human consumption. Health Certificate certifies :that the product comes from an establishment which has implemented a HACCP based quality management programme, that product have been caught and handled on board vessels which satisfy EU Regulation , that have been packaged, stored and transported in accordance with EU Regulation., that have satisfactorily undergone the official controls laid down in EU Regulation.

Advantages of food safety certification are increased customer confidence, reduced risks, better image in importing countries, increased market access and increased profits.

2.**Catch Certification**(certifying **the legality of catches**).

To combat IUU ( Illegal, Unreported and Unregulated) fishing. Addresses compliance of fishers with respect to access to fishing areas in terms of space and time, target species, fishing methods, agreed quotas and reporting rules. It’s a single attribute certification. Catch certification is a mandatory requirement for export to EU. Also to those countries which re-export imported seafood from India after reprocessing and value additions.Several agreements are in place as part of legality of catch. They are:

- United Nations Convention on the Law of the Sea (UNCLOS, 1982).
- FAO International Plan of Action to Prevent, Deter and Eliminate IUU fishing (2001).
- United Nations Fish Stock Agreement ( UNFSA,995).
- The present EU Regulation makes EU market inaccessible for IUU fishing activity.
- The nodal agency in India for Catch Certification is MPEDA.

**3.Country of Origin Certification.**

Entitles business owners to a preferential duty program under U.S. Customs law or through a trade agreement. Many Free Trade Agreements (FTAs) have a specific CoO Certificate; e.g., GSP,NAFTA, APFTA. Determines whether goods can be legally imported/exported (a certificate of origin may be required by the government of an importing country). Issued by Chamber of Commerce, MPEDA or EIA.

B**. *Private initiated certification schemes.***

*These* certifications are voluntary in nature.

They are mainly environmental certification, and food safety certification initiated by private establishments and retailers.

**1.Environmental Certification.**

The purpose is to prove 5e environmental sustainability of a fishery product. It is a muti attribute certification which can be first,second or third party certification.

Certification for marine capture fisheries.

1.**Marine Stewardship Council (MSC)**.

MSC is an international non-profit Organization which sets standards for sustainable fishing ;Based on 3 principles:

Principle 1: sustainable fish stock- targeted stock should be at sustainable level.

Principle 2: minimising environmental impact - fishing operations should be managed to maintain the structure, productivity, function and diversity of ecosystem on which the fishery depends.

Principle 3: effective management.

Fishery is assessed using 28 performance indicators (PIs) by independent team of experts.

**Advantages:**

- Market penetration.
- Price premium for certified products.
- Increased profit.
- Disadvantages:
- High cost of certification which ranges fromUS$ 20,000 to $ 100,000.
- Disproportionate sharing of profits among supply chain partners.
- Acts as invisible non-tariff trade barrier.

2.**Friend of the Sea (FoS**)

Certification is for both wild caught and aquaculture products. Criteria compliance is verified by independent accredited certification bodies.Essential criteria are :

- Product should not originate from over exploited, depleted, data deficient or recovering stock.
- The fishing method should not impact the seabed.
- The fishing method should be selective with low discards.
- The fishing should respect all legal requirements.

**Certification for sustainable aquaculture.**

**1.*Aquaculture Stewardship Council (ASC)***

Certification applicable for aquaculture farms, processing plants and hatcheries are;

- BAP certification by Global Aquaculture Alliance (GAA)
- Certify farms meeting the GAA criteria under Best Aquaculture Practices BAP).

There are other single attribute environmental certifications like Dolphine Safe Tuna and Turtle Safe Shrimp.

**Food safety certification initiated by private agencies.**

Despite the certifications by government agencies, rejections continue to occur, pointing to the inadequacies of such systems. As a result many buyers, especially major retailers like Walmart, Marks &Spencer, Tesco etc, in Europe and the US proposed private food safety certification system like BRC, IFS and ISO.

**1.*British Retailer Consortium (BRC)*:**

standards for food safety developed by food industry experts from retailers, manufacturers and food service organisations. Aim is to harmonise food safety standards across supply chain. First published in 1998, now in its eighth issue. Well established globally. It focuses on food safety, integrity, legality and quality in food and food ingredient manufacturing, processing and packing industry. Adopted in 130+ countries.

BRC A+ - unannounced audit.

BRC A - announced audit.

**Advantages:**

- increased customer confidence
- better brand image
- increased profitability
- achievable and cost effective
- highly trained auditors worldwide.

**2. *International Food Standard (IFS)***

Developed by German Retail Association in 2002. A common food safety standard with a uniform evaluation system used to qualify and select suppliers.system is based on HACCP supported by PRPs like GMP, GLP and GHP. IFS meet the criteria of GFSI.

**3. *ISO 22000:***

It follows CAC "food code", an internationally recognized series of standards and guidelines. Certification is done by accredited third party certifying bodies. Developed jointly by CAC, FAO and WHO. Based on Codex principles of food hygiene.

**Benefits:**

- The ability to consistently provide food that are safe and meet regulatory requirements.
- Improved risk assessment.

**Conclusion**.

At present all the seafood exporting companies in India has implemented the certification requirements of EIC/EIA and also MPEDA as these are mandatory certifications.Many companies especially those engaged in the production of value added products have also implemented private food safety certifications such as ISO22000, BRC, IFS etc.As far as environmental certifications are concerned the concept is yet to gain acceptance among Indian seafood exporters and only a few companies are certified by ASC , GAA and FoS for aquaculture. So far MSC has certified only one fishery in India, the short neck clam of lake Ashtamudi in Kollam.

# Chapter 13

## Iron-Calcium Fortified Fish Soup Powder: a Deterrent for Malnutrition

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Fortified fish soup powder was developed at ICAR-Central Institute of Fisheries Technology with the objective of improving mineral status (of calcium and iron) and hemoglobin content of anemic adolescent girls

Fast Facts about Malnutrition

**General information**

- Two billion people in the world suffer from various forms of malnutrition.[1]
- Malnutrition is an underlying cause of death of 2.6 million children each year – a third of child deaths globally.[2,3]
- 1 in 4 of the world's children are stunted [4]; in developing countries this is as high as one in three.[5] This means their bodies fail to develop fully as a result of malnutrition.
- Undernutrition accounts for 11 per cent of the global burden of disease and is considered the number one risk to health worldwide. [5]

**Economic impact**

- Adults who were malnourished as children earn at least 20% less on average than those who weren't. [6]
- Countries may lose two to three percent of their Gross Domestic Product (GDP) as a result of iron, iodine, and zinc deficiencies. [7]
- Estimates show annual investments of US$ 347 million to provide micronutrients to 80 percent of the world's malnourished would yield US$ 5 billion in improved earnings and healthcare spending.[7]
- It is calculated that each dollar spent on nutrition delivers between US$ 8 and US$138 of benefits. [8]

**Micronutrient deficiencies**

- **It is estimated half of anaemia cases are due to iron deficiency.**[9] Almost half of children in low- and middle-income countries – 47% of under-fives – are affected by anaemia, impairing cognitive and physical development.[10] Iron is a key component of micronutrient blends which are used in large-scale and targeted fortification programs.
- **Iodine deficiency is the greatest single cause of mental retardation and brain damage.** It can easily be prevented by adding iodine to salt. [11] Between 1990 and 2009, the number of households consuming iodized salt rose from 20% to 70%. Coincidently, the number of countries in which iodine-deficiency disorders were considered a public health concern reduced by 43% between 1993 and 2007. [12]
- **Vitamin A deficiency causes early childhood blindness and increases the severity of infections and anaemia.** It affects an estimated 190 million pre-school aged children, and 19 million pregnant and breastfeeding women globally. Vitamin A can be added to

cooking oil as well as wheat and maize flour. It is also included in micronutrient powders. [13]

- **Zinc deficiency affects children's health and physical growth;** it is also essential for mothers during pregnancy. It is estimated to cause 4% of deaths in pre-school aged children in lower-income countries. [5] Zinc supplementation improves growth in stunted children and can be included in wheat flour, maize flour or rice.

**The Global Nutrition Report 2017** was presented at Milan in Italy recently and it emphasizes on the urgent need to integrate our actions on global nutrition if India hopes to meet its Sustainable Development Goals of Agenda 2030. `

- About 38 per cent of the children under five are affected by stunting
- 21 per cent of children under 5 have been defined as 'wasted' or 'severely wasted' – which means that they do not weigh enough for their height.
- Moreover, 51 per cent of the women of reproductive age suffer from anemia and
- 22 per cent of adult women are overweight.

While the report does indicate that India has shown some progress in addressing childhood stunting for children under the age of 5, **it presents worse outcomes in the percentage of reproductive-age women with anaemia,** and is off course in terms of reaching its targets for reducing adult obesity and diabetes.

The Millennium Development Goals (MDGs) India Country Report 2015 outlines India's progress and the challenges in achieving the goals and targets set at the United Nations Millennium Summit in September 2000 by 189 heads of States, including India, to adopt measures—to fight against poverty, hunger, illiteracy, gender inequality, disease and environmental degradation. To quote from the report " though there are impressive achievements in several sectors, all the MDGs are unlikely to be met". The most worrying aspect which should concern us is that the largest undernourished population in the world call India their home. The proportion of underweight children under 5 declined from 52% in 1990 to 33% by 2015, but is still far from the target of reducing it by half.

In India, nutrient deficient diets are a fact of everyday life for millions. It is a matter of grave concern that India is doing dismally on the nutrition front; according to the World Economic Forum, its Global Competitive Index with respect to infant mortality rate is a dismal 114/140. One of the reasons for the large prevalence of undernourished and underweight children with stunted growth in India is the mutli-micronutrient deficiencies that these children suffer from. It is our strong perception that even smallest of right kind of interventions may go a long way in improving this statistic. Current approaches to address malnutrition have serious limitations. Interestingly, fish is probably the most affordable source to provide almost 40 essential nutrients. A soup powder incorporating the nutritional goodness of fish and fortified with iron and calcium by taking into account WHO-recommended RDA values has been developed at ICAR-Central Institute of Fisheries Technology, Kochi.

- Iron is an important constituent of hemoglobin which carries oxygen from the lungs to the rest of the body.
- Iron helps in maintaining a healthy immune system and aids in energy production
- Calcium keeps bones and teeth strong, thereby supporting skeletal structure and function
- Calcium plays key roles in cell signaling, blood clotting, muscle contraction and nerve function

Innovation at ICAR-CIFT is backed by sound science and research. The fortified fish soup powder has undergone rigorous biochemical and microbiological quality assessment in addition to sensory evaluation. Feeding studies in albino rats have been conducted to determine the effect on growth and well-being of the animals. The compositional analysis reveals the biochemical richness of the product with special reference to its protein, fat and mineral content all of which contribute significantly to an individual's nutritional status. A variant of the product- a ready to drink fish soup with retort pouch technology that has a stable shelf life of 6 months at ambient temperatures has been developed and perfected.

Integrated Child Development Scheme (ICDS), Jowai, West Jaintia District Hills District, Meghalaya and Health Department, Jowai, Child Development Project Officer, Thadlaskein Block, Jowai, and ICAR-CIFT Scientists met on the On November 21, 2016, on the occasion of World Fisheries Day to chalk out a one month program of distributing fortified fish soup to adolescent girls selected to improve their hemoglobin levels and health status. Fifty adolescent girls, age ranging from 11-16 whose blood hemoglobin levels were 9 or below, were selected from three villages. Preliminary baseline data with respect to their age, height, weight, Mid Upper Arm Circumference were recorded.

Following this the subjects were provided with 100 ml of hot soup freshly prepared with 10 g of Fortified Fish Soup Powder once every day for 30 days in a community setting. The intervention was closely monitored by ICDS officials and community workers for the entire period of study. All the girls were gathered each day and a health worker given the charge of preparing the soup powder with freshly added vegetables ensured that each girl got her soup every single day. These strategies ensured 100% compliance. Blood hemoglobin analysis post intervention showed that all the adolescent girls recorded a statistically significant rise in blood hemoglobin levels as indicated in the statement below.

| STATEMENT SHOWING THE PARTICULARS OF THE SELECTED ADOLESCENT GIRLS FOR IMPLEMENTATION OF FISH POWDER SOUP UNDER AMLAREM ICDS PROJECT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sl. No | Name of Adolescent Girls | Age | Village | Weight | Height in ft/inches | Mid-arm Circumference | Heamoglobin level before | Heamoglobin level after 1 Month | Remarks |
| 1 | Mardeimi Tariang | 12 | Thangbuli | 34 | 4.58 | 8 | 10.8 | 11 | The number of 18 selected Adolescent Girls for the Fish Soup Powder has showned an increased in the HB level but 7 numbers of Adolescent Girls shown that their HB level remained the same. |
| 2 | Vani emi Buam | 11 | Thangbuli | 29 | 4.49 | 7.5 | 11 | 11 | |
| 3 | Riwanroi Suting | 12 | Thangbuli | 28 | 4.50 | 7 | 10.8 | 10.8 | |
| 4 | Dikimuh Manner | 12 | Thangbuli | 35 | 4.45 | 8 | 9.4 | 12 | |
| 5 | Pynshngain Pohleng | 11 | Thangbuli | 45 | 4.45 | 9 | 9.4 | 10.8 | |
| 6 | Kyrshanborlang Dkhar | 18 | Thangbuli | 35 | 4.42 | 8 | 8 | 9 | |
| 7 | Cheris Langshiang | 15 | Thangbuli | 49 | 4.60 | 9 | 7.8 | 9.2 | |
| 8 | Shunkii Rongngi | 11 | Thangbuli | 28 | 4.49 | 7 | 9.4 | 9.4 | |
| 9 | Ishia Kassar | 11 | Thangbuli | 28 | 4.00 | 7 | 9.4 | 9.4 | |
| 10 | Mansharu Buam | 11 | Thangbuli | 35 | 4.42 | 8.5 | 9.4 | 9.4 | |
| 11 | Lumiman Rongngi | 13 | Thangbuli | 30 | 4.50 | 7.5 | 8 | 9 | |
| 12 | Nidakmen Bataw | 11 | Thangbuli | 35 | 4.50 | 8 | 10.8 | 11 | |
| 13 | Olidaki Buam | 12 | Thangbuli | 44 | 4.58 | 9 | 9.4 | 10 | |
| 14 | Diyalang Khyriem | 14 | Thangbuli | 25 | 4.50 | 6.5 | 10.8 | 10.8 | |
| 15 | Safetycare Pohleng | 12 | Thangbuli | 28 | 4.50 | 7 | 9.4 | 11 | |
| 16 | Buam Lakhon | 14 | Thangbuli | 48 | 4.60 | 9 | 8.5 | 9.4 | |
| 17 | Deisi Surong | 16 | Thangbuli | 40 | 4.59 | 8.5 | 11 | 11 | |
| 18 | Hasina Mulad | 14 | Umladkhur | 42 | 5.00 | 8 | 8 | 9 | |
| 19 | Pretty Mulad | 12 | Umladkhur | 35 | 4.59 | 8 | 9 | 12.5 | |
| 20 | Wanisa Pohlong | 11 | Umladkhur | 29 | 4.40 | 7 | 8 | 12.5 | |
| 21 | Sabina Surong | 13 | Umladkhur | 40 | 4.42 | 8 | 9.4 | 10.8 | |
| 22 | Deimonmi Sumer | 13 | Umladkhur | 35 | 4.42 | 8 | 7.8 | 10.8 | |
| 23 | Lamare Buam | 15 | Umladkhur | 44 | 4.58 | 9.5 | 10.8 | 11 | |
| 24 | Rilang Khyriem | 12 | Umladkhur | 38 | 4.58 | 8.5 | 10 | 10.8 | |
| 25 | Wanjuh Buam | 14 | Umladkhur | 30 | 4.42 | 8 | 10.8 | 11 | |

District Programme Officer
ICDS (Cell) West Jaintia Hills
District Jowai.

Child Development Project Officer
ICDS Project Amlarem
West Jaintia Hills District

Screening of Adolescent Girls at Jarain PHC, Amlarem, West Jaintia Hills District, Meghalaya prior to the start of the intervention study using the fortified fish soup powder.

Adolescent girls of Mihmyntdu Lumpyrdi A.W.C under Thadlaskein Block, West Jaintia Hills District, Meghalaya consuming the fortified fish soup powder as part of the intervention study.

Adolescent girls of Thangbuli Village Amlarem Block, West Jaintia Hills District, Meghalaya consuming the fortified fish soup powder as part of the intervention study.

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# Chapter 14

**Development of standards for ensuring seafood safety**

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Food Safety has been the buzz word in recent days as there are increasing consumer awareness on hazards present in food as well as the ombudsmen role played by independent media. Although regulatory regime across the world has taken proactive steps, in most of the cases it has been a knee-jerk reaction to the impending crisis. Defining the actual goal of food safety has been an arduous task as there are umpteen interrelated factors that influence the intended goals. Some of the definitions on food safety put forward by international agencies are as follows:

- Concept that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use (ISO 22000:2005)
- A suitable product which when consumed orally either by a human or an animal does not cause health risk to consumer (USDA-FSIS)
- Range of food related activities from prevention and surveillance to detection and control (ASTHO)

Food Safety also encompasses many aspects of handling, preparation and storage that introduces or controls chemical, microphysical and microbiological hazards. Quality of raw material, presence of pathogens, processing methods, climate change and cross-contamination also significantly impacts any food safety measure.

Seafood is always in news as it is proclaimed to be most nutritious and healthy food as well as being linked to increasing number of foodborne outbreaks across the globe. In the nutritional front, fish accounts for 17 percent of the global population intake of animal protein and 6.7% of all protein consumed (FAO, 2016). The world per capita consumption of fish and fishery products has increased from 9.9 Kg in 1960s to 20 Kg in 2014.

Seafood trade apart from being highly volatile accounts for 10 percent of total agricultural exports and 1 percent of world merchandise trade in value terms. In 2010, the quantum of seafood trade has crossed US$109 billion. Ninety percent of global trade in fish and fishery products consists of processed products, where 39% of the total quantity is traded as frozen. This trend indicates high mobility of the fishery products across the globe, which demands stringent traceability system in place to track the movement of the commodity from harvest to consumers. Nearly 75% of the volume of seafood in international trade is imported by developed nations and 50% of that is exported by developing nations. Hence, food safety issues concerned with seafood is no more local or restricted to a particular geographical location, but has acquired global dimension. Some of the major food safety concerns linked to seafood are:

- presence of Ciguatera toxin in reef dwelling finfish
- histamine fish poisoning

- norovirus and *Vibrio parahaemolyticus* in raw shellfish
- Salmonella in shrimp products
- *Clostridium botulinum* in processed products
- high level of environmental pollutants
    - mercury, cadmium, lead
    - polychlorinated biphenyls and pesticides
- antimicrobial residues in aquaculture products

Apart from the above mentioned concerns which are mostly global, there are regional issues like use of adulterants like formaldehyde to retard decomposition process, ammonia to mask spoilage, use of un-approved additives (preservatives), and high level of pesticides in dry fish and presence of emerging pathogens in fisheries environs.

The most challenging task for the policy makers has been to link incidences of foodborne illnesses with a particular food commodity. It needs a strong surveillance and monitoring mechanism to unequivocally attribute a particular food commodity. In USA, Centre for Disease Control (CDC) does the massive work of source tracking for major foodborne pathogens through pulsenet programmes. The recent report by CDC (Scallan et al., 2011) indicates that 31 major pathogens reported in the United States caused 9.4 million episodes of foodborne illness, 55,961 hospitalizations and 1,351 deaths during 2. Most (58%) illnesses were caused by norovirus, followed by non-typhoidal *Salmonella* spp. (11%), *Clostridium perfringens* (10%), and *Campylobacter* spp. (9%). Leading causes of hospitalization were non-typhoidal *Salmonella* spp. (35%), norovirus (26%), Campylobacter spp. (15%), and *Toxoplasma gondii* (8%). Leading causes of death were non-typhoidal *Salmonella* spp. (28%), *T. gondii* (24%), *Listeria monocytogenes* (19%), and norovirus (11%). In India, the recently established National Centre for Disease Control (formerly, National Institute of Communicable Diseases), Ministry of Health and Family Welfare, Government of India has a similar mandate to undertake activities on outbreak investigation and provide referral diagnostic services.

In absence of etiological data linked to seafood, the export rejection figures provides an indirect account of food safety hazards associated with seafood. Import refusals and rejections from countries like USA, Japan, Russia and EU are on the rise because of presence of biological and chemical hazards in seafood, leading to heavy economic loss by seafood industries. The most common import refusal of seafood by USA is due to presence of *Salmonella*, Listeria, filth or illegal veterinary drugs. The RASFF portal of EU indicates alert notifications due to presence of veterinary drug residues, heavy metals, histamine, foreign bodies, biotoxin, defective packaging, incorrect labelling, improper health certificate, unapproved colour and additives and organoleptic aspects. In recent months most of the rejections from Japan had been due to presence of furazolidone (AOZ) and Ethoxyquin in shrimp. Seafood rejections from Russia are mostly due to presence of high load of mesophilic bacteria, coliforms, pathogens and presence of crystal violet.

Genesis of Food Safety Standards and Regulations

Food safety standards can be classified as regulatory, voluntary, Government/Statutory, private, domestic, international or benchmarked depending upon its scope and range of application. Most of these standards have evolved based upon sanitary and phyto-sanitary (SPS) requirements, economic interest, risk analysis or as precautionary approach. The precautionary approach mostly relies on perception i.e. equivalent level of protection, appropriate level of protection (ALOP) or as low as reasonably achievable (ALARA).

In international trade, sanitary and phytosanitary measures are envisioned to be based on sound scientific principles that ensure food safety and do not anyway compromise the production potential and resources of a particular country. These measures should not be linked to prevent market access based on non-scientific reasons, and are requirements but not sufficient condition of trade. As per the Annex A of WTO Agreement, Sanitary and phytosanitary measures are applied to (i) protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms (ii) to protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs (iii) from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests and (iv) to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests. WTO encourages members to use accepted International standards by Codex Alimentarius Commission, OIE (World Organization for Animal Health) and IPPC (International Plant Protection Convention). Countries may introduce or maintain SPS measures that provide higher level of protection than the current international or Codex standards.

## **Salient features of some Export regulations related to Seafood**

### European Union

European Union is the biggest importer of fish and fishery products in the world. The food safety regulations set by EU is harmonised, gets periodically updated, transparent and based on principles of risk assessment. The key elements of EU requirements for import of seafood are (a) certification by a competent authority (b) compliance to hygiene and public health requirements in terms of structure of vessels, landing sites, processing establishments and on operational processes, freezing and storage (c) certified production area for bivalves (d) national control plan on heavy metals, contaminants, residues of pesticides and veterinary drugs (e) approval of establishments.

The legal acts of EU are managed through regulations, directives, decision, recommendations and opinions.

Regulation: A binding legislative act applied in entirety across EU

Directives: A "directive" is a legislative act that sets out a goal that all EU countries must achieve.

Decision: A "decision" is binding on those to whom it is addressed (e.g. an EU country or an individual company) and is directly applicable.

Recommendations: A "recommendation" is not binding act that allows the institutions to make their views known and to suggest a line of action without imposing any legal obligation on those to whom it is addressed.

Opinions: An "opinion" is an instrument that allows the institutions to make a statement in a non-binding fashion, in other words without imposing any legal obligation on those to whom it is addressed.

Some of the important EU legislations related to food safety issues of fish and fishery products are as follows:

Regulation (EC) No 178/2002: General principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety

Regulation (EC) No 852/2004: Hygiene of foodstuffs.

Regulation (EC) No 853/2004: Specific hygiene rules for food of animal origin

Regulation (EC) No 854/2004: Specific rules for the organisation of official controls on products of animal origin intended for human consumption

Regulation (EC) No 2073/2005: Microbiological criteria for foodstuffs

Regulation (EC) No 882/2004: Official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules

Regulation (EC) No 1881/2006: Maximum levels for certain contaminants in foodstuffs

Regulation (EC) No 333/2007: Methods of sampling and analysis for the official controls for the levels of lead, cadmium, mercury, inorganic tin, 3-MCPD and benzo(a)pyrene in foodstuffs

Regulation (EC) No 1883/2006: Methods of sampling and analysis for the official control of levels of dioxins and dioxin-like PCBs in certain foodstuffs

Regulation (EC) No 396/2005: Maximum residue levels of pesticides in or on food and feed of plant and animal origin

Council Directive 96/23/EC: Measures to monitor certain substances and residues thereof in live animals and animal products

Commission Decision (2005/34/EC): Harmonised standards for the testing for certain residues in products of animal origin imported from third countries

Commission Decision (2002/657/EC): Implementing Council Directive 96/23/EC concerning the performance of analytical methods and the interpretation of results

Commission Decision (98/179/EC): Official sampling for the monitoring of certain substances and residues thereof in live animals and animal products

Commission Decision (2004/432/EC): Approval of residue monitoring plans submitted by third countries in accordance with Council Directive 96/23/EC

Council Directive 96/22/EC: Prohibition on the use in stock farming of certain substances having a hormonal or thyrostatic action and of beta-agonists

Regulation (EC) No 470/2009: Community procedures for the establishment of residue limits of pharmacologically active substances in foodstuffs of animal origin

Commission Regulation (EU) No 37/2010: Pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin

Commission Regulation (EC) No 2023/2006: Good manufacturing practice for materials and articles intended to come into contact with food

Commission Regulation (EC) No 1935/2004: Materials and articles intended to come into contact with food

Commission Regulation (EU) No 1129/2011: Amendment to Annex II to Regulation (EC) No 1333/2008 of the European Parliament and of the Council by establishing a Union list of food additives

Commission Regulation (EC) No 1333/2008 : Food Additives

Commission Regulation (EC) No 1334/2008: Flavourings and certain food ingredients with flavouring properties for use in and on foods

Commission Regulation (EC) No 1331/2008: Establishing a common authorisation procedure for food additives, food enzymes and food flavourings

Directive 2000/13/EC: Labelling, presentation and advertising of foodstuffs (until 12 December 2014)

Commission Regulation (EU) No 1169/2011: Provision of food information to consumers, amending Regulations

Commission Regulation (EU) No 1379/2013: Common organisation of the markets in fishery and aquaculture products

USA

In USA both Federal and State Regulatory agencies are involved in ensuring safety and quality of seafood. Multiple federal agencies are involved in regulatory oversight of seafood for both importation and export.

United States Department of Agriculture (USDA) oversees the implementation of country of origin labelling (COOL) regulation enacted under the Farm Security and Rural Investment Act of 2002. This law requires that all retailers, such as full-line grocery stores or supermarkets must notify their customers with information regarding the source of certain foods. The COOL regulation for fish and shellfish (7 CFR Part 60) came into force in 2005. Apart from the country of origin, all fish and shellfish covered commodities must be labelled to indicate whether they are wild caught or farm-raised.

United States Fisheries and Wildlife Service (USFWS) is also involved in regulation of import and export of shellfish and fishery products through Convention on International Trade in Endangered Species (CITES) act (50 CFR Part 23), Endangered Species Act (50 CFR Part 17), General Permit Procedures (50 CFR Part 13), Lacey Act (injurious wildlife) (50 CFR Part 16), Marine Mammal Protection Act (50 CFR Part 18) and Wildlife (import/export/transport) act (50 CFR Part 14). Live farm-raised fish and farm-raised fish eggs are exempted from export declaration and licensing requirements. Imports or exports of any sturgeon or paddlefish product, including meat, caviar, and cosmetics made from sturgeon eggs, dead un-eviscerated salmon, trout and char and live fertilized eggs from these salmonid fish require a permit. Aquatic invertebrates and other animals that are imported or exported for human or animal consumption but that do not meet the definition of shellfish such as squid, octopus, cuttlefish, land snails, sea urchins, sea cucumbers and frogs are also covered under this provisions.

National Oceanic and Atmospheric Administration (NOAA) functioning under the United States Department of Commerce (USDC) provides voluntary seafood inspection program for fish, shellfish, and fishery products to the industry as per the 1946 Agricultural Marketing Act. The NOAA Seafood Inspection Programme often referred to as the U.S. Department of Commerce (USDC) Seafood Inspection Programme provides services such as establishment sanitation inspection, system and process audits, product inspection and grading, product lot inspection, laboratory analyses, training, consultation and export certification. NOAA Fisheries is the Competent Authority for export health certification and IUU catch documentation for US seafood products meant for export to EU and non-EU countries.

The U.S. Food and Drug Administration (USFDA) is vested with the primary Federal responsibility for the safety of seafood products in the United States. It operates a mandatory safety program for all fish and fishery products under the provisions of the Federal Food, Drug and Cosmetic (FD&C) Act, the Public Health Service Act, and related regulations. The most important regulation enacted by USFDA was “Procedures for the Safe and Sanitary Processing and Importing of Fish and Fishery Products” published as final rule 21 CFR 123 on 18$^{th}$ December 1995 and came into force on 18$^{th}$ December 1997. It required processors to adopt the preventive system of food safety controls known as HACCP (Hazard Analysis and Critical Control Point). Seafood was the first food commodity in the U.S. to adopt HACCP in USA. For screening imports, USFDA uses a tool “Predictive Risk-based Evaluation for Dynamic Import Compliance Targeting (PREDICT)”, that targets higher risk products for examination and sampling and minimizes the delay in shipments of lower risk products.

Food Safety and Modernization Act (FSMA) is the most important milestone event in the food safety scenario in USA. It was signed in to law on 4$^{th}$ January 2011 which sifted the focus from responding to a contamination to prevention of the actual cause. The salient features of FSMA act are as follows:

Sec. 103. Hazard analysis and risk-based preventive controls (HARPC): Requires human and animal food facilities to

- evaluate hazards that could affect food safety;
- Identify and implement preventive controls to prevent hazards;
- Monitor controls and maintain monitoring records; and
- Conduct verification activities

Sec. 106. Protection against intentional adulteration

Sec. 111. Sanitary Transportation of Food

Sec. 301. Foreign supplier verification program

- Requires importers to verify their suppliers use risk-based preventive controls that provide same level of protection as U.S. requirements.

Sec. 302. Voluntary qualified importer program

- Allows for expedited review and entry; facility certification required

Sec. 303. Certification for high-risk food imports

- FDA has discretionary authority to require assurances of compliance for high-risk foods

Sec. 304. Prior notice of imported food shipments

- Requires information on prior refusals to be added to prior notice submission
- Effective July 3, 2011

Sec. 307. Accreditation of third-party auditors

- FDA can rely on accredited third parties to certify that foreign food facilities meet U.S. requirements

Sec. 308. Foreign Offices of the Food and Drug Administration.

- Establish offices in foreign countries to provide assistance on food safety measures for food exported to the U.S.

  Sec. 309. Smuggled Food
- In coordination with DHS, better identify and prevent entry of smuggled food
- Rules on anti-smuggling strategy is already framed

China

In recent years China has strengthened its SPS measures and has taken a number of precautionary steps to ensure safety to its population. Some of the important regulations enacted by Peoples Republic of China are as follows:

- GB 2763—2012: National food safety standard on Maximum residue limits for pesticides in food
- GB 2762—2012: National food safety standard on Contaminants in Food
- GB-2010: National Food Safety Standard for Pathogen Limits in Food (GAIN Report No. 12063)
- GB 2733-2005: Hygienic Standard for Fresh and Frozen Marine Products of Animal Origin
- GB 2760-2011 additives
- GB 10136-1988 Hygienic standard for salt & liquor-saturated aquatic products of animal origin

Russia

Russia has a comprehensive regulatory framework for fish and fishery products. The hygienic requirements are different from other countries as some of the microbiological parameters are expressed as absent in 0.001g or 0.01g. Also some different nomenclature like QMAFAnM is followed instead of APC. The Russian regulation currently in force pertaining to fish and fishery products is as follows:

- Hygienic requirements for safety and nutrition value of food products. Sanitary and epidemiological rules and regulations, sanpin 2.3.2.1078-01

**Japan**

Compared to other countries, SPS measures followed by Japan is very stringent. Many additives which are in the approved list of Codex are banned or prohibited in Japan. Japan uses a positive list system for MRL of agricultural chemicals in foods. A uniform limit of 0.01 ppm is followed for the compounds for which no risk assessment is done but which are included in the positive list (MHLW Notification No. 497, 2005). MHLW uses a toxicological threshold of 1.5 µg/day as the basis to determine the uniform limit. Substances having no potential to cause damage to human health are specified by MHLW Notification No.498. 2005. The MRL list is mentioned as compositional specification of foods (MHW Notification, No. 370, 1959, amendment No.499 2005, updated as on March 15, 2013)

The relevant food safety acts of Japan as enacted by Ministry of Health, Labour and Welfare and other agencies are as follows:

- Food Sanitation Act (Act No.233, 1947): Latest Revision on June 5, 2009, Act No. 49)

- Specifications and Standards for Food and Food Additives, Latest Revision on September 6, 2010, MHLW Notification No. 336
- Japan's Specifications and Standards for Food Additives" (Eighth Edition). Published by the Ministry of Health, Labour and Welfare in 2007
- Food Safety Basic Act (Act No. 48, 2003)
- Agricultural Chemicals Regulation Law (Law No. 82, 1948)

  Codex Alimentarius Commission

  The Codex Alimentarius Commission (CAC) was established in 1961-1963 by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) to implement their Joint FAO/WHO Food Standards Programme. CAC has the mandate to formulate food standards, code of practice, guidelines and recommendations to protect health of consumers, Ensure fair practices in food trade and to promote coordination of all food standards work undertaken by international governmental and non-governmental organizations. Codex operates through thee standing expert scientific bodies convened under the auspices of FAO and WHO to generate food data and provide risk-assessment type advice:
- Joint Expert Committee on Food Additives (JECFA)
- Joint Meeting on Pesticide Residues (JMPR)
- Joint Meeting on Microbiological Risk Assessment (JEMRA)

  Different subject committees and commodity committees, adhoc inter-governmental task forces and regional coordinating committees function and under codex. Codex Committee on Fish and Fisheries Products (CCFFP) is entrusted with the task of formulating standards for different product categories. Although Codex standards on Fish and Fishery Products specifically do not address food safety requirements, but provide a strong framework for production, hygienic requirements and sampling.

  Available Codex Standard for Fish and Fishery Products

| | | |
|---|---|---|
| | Standard for Canned Salmon | CODEX STAN 3-1981 |
| | Standard for Quick Frozen Finfish, Eviscerated or Uneviscerated | CODEX STAN 36-1981 |
| | Standard for Canned Shrimps or Prawns | CODEX STAN 37-1981 |
| | Standard for Canned Tuna and Bonito | CODEX STAN 70-1981 |
| | Standard for Canned Crab Meat | CODEX STAN 90-1981 |
| | Standard for Quick Frozen Shrimps or Prawns | CODEX STAN 92-1981 |
| | Standard for Sardines and Sardine-Type Products | CODEX STAN 94-1981 |
| | Standard for Quick Frozen Lobsters | CODEX STAN 95-1981 |
| | Standard for Canned Finfish | CODEX STAN 119-1981 |
| . | Standard for Quick Frozen Blocks of Fish Fillets, Minced Fish Flesh and Mixtures of Fillets and Minced Fish Flesh | CODEX STAN 165-1989 |
| . | Standard for Quick Frozen Fish Sticks (Fish Fingers), Fish Portions and Fish Fillets - Breaded or in Batter | CODEX STAN 166-1989 |
| . | Standard for Salted Fish and Dried Salted Fish of the Gadidae Family of Fishes | CODEX STAN 167-1989 |
| . | Standard for Dried Shark Fins | CODEX STAN 189-1993 |
| . | General Standard for Quick Frozen Fish Fillets | CODEX STAN 190-1995 |
| . | Standard for Quick Frozen Raw Squid | CODEX STAN 191-1995 |

| | | |
|---|---|---|
| . | Standard for Crackers from Marine and Freshwater Fish, Crustaceans and Molluscan Shellfish | CODEX STAN 222-2001 |
| . | Standard for Boiled Dried Salted Anchovies | CODEX STAN 236-2003 |
| . | Standard for Salted Atlantic Herring and Salted Sprat | CODEX STAN 244-2004 |
| . | Standard for Sturgeon Caviar | CODEX STAN 291-2010 |
| . | Standard for Live and Raw Bivalve Molluscs | CODEX STAN 292-2008 |
| . | Standard for Fish Sauce | CODEX STAN 302-2011 |

Code of Practice

| | |
|---|---|
| Code of Practice for Fish and Fishery Products | CAC/RCP 52-2003 |

Guidelines

| | |
|---|---|
| Guidelines for the Sensory Evaluation of Fish and Shellfish in Laboratories | CAC/GL 31-1999 |
| Guidelines on the Application of General Principles of Food Hygiene to the Control of Pathogenic Vibrio Species in Seafood | CAC/GL 73-2010 |
| Guidelines on the Application of General Principles of Food Hygiene to the Control of Viruses in Food | CAC/GL 79-2012 |
| Model Certificate for Fish and Fishery Products | CAC/GL 48-2004 |
| Guideline Procedures for the Visual Inspection of Lots of Canned Foods for Unacceptable Defects | CAC/GL 17-1993 |
| Guidelines on Good Laboratory Practice in Pesticide Residue Analysis | CAC/GL 40-1993 |
| General guidelines on sampling | CAC/GL 50-2004 |
| Guidelines on the Use of Mass Spectrometry (MS) for Identification, Confirmation and Quantitative Determination of Residues | CAC/GL 56-2005 |

Codex standard applicable to Fish and Fishery Products

| | |
|---|---|
| General Standard for Contaminants and Toxins in Food and Feed | CODEX STAN 193-1995 |
| General Standard for the Labelling of Prepackaged Foods | CODEX STAN 1-1985 |
| Standard for Food Grade Salt | CODEX STAN 150-1985 |
| General Standard for Food Additives | CODEX STAN 192-1995 |
| General Methods of Analysis for Contaminants | CODEX STAN 228-2001 |
| Recommended Methods of Analysis and Sampling | CODEX STAN 234-1999 |
| General Methods of Analysis for Food Additives | CODEX STAN 239-2003 |

**Bureau of Indian Standards (BIS)**

Bureau of Indian Standards (BIS) functioning under the Ministry of Consumer Affairs, Food and Public Distribution, Government of India. It came into existence on 01 April 1987 through an Act of Parliament on 26 November 1986. It was functioning previously as Indian Standards Institution which was established on 06 January 1947. BIS has so far formulated 64 standards related to fish and fishery products, out of which 33 are active. All these standards are voluntary, which addresses method of production, quality and safety requirements. It also stipulates the method of testing and sampling. There is an attempt by FSSAI to re-draft all BIS standards related to fish and fishery products as most of the food safety requirements are not in sync with the current national standards.

BIS Standards on Fish and Fishery Products

| | | |
|---|---|---|
| IS 2168 | 1971 | Pomfret Canned in Oil |
| IS 2236 | 1968 | Prawns/Shrimp Caned in Brine |
| IS 2237 | 1997 | Prawns (Shrimps) - Frozen |
| IS 3336 | 1965 | Shark Liver Oil for Veterinary Use |
| IS 3892 | 1975 | Frozen Lobster Tails |
| IS 4304 | 1976 | Tuna Canned in Oil |
| IS 4780 | 1978 | Pomfret, Fresh |
| IS 4793 | 1997 | Whole Pomfret - Frozen |
| IS 5734 | 1970 | Sardine Oil |
| IS 6121 | 1985 | *Lactarius* sp Canned in Oil |
| IS 6122 | 1997 | Seer Fish (*Scomberomorus* Sp.) - Frozen |
| IS 6123 | 1971 | Seer Fish (*Scomberomorus* spp.), Fresh |
| IS 7143 | 1973 | Crab Meat Canned in Brine |
| IS 7313 | 1974 | Glossary of Important Fish Species of India |
| IS 7582 | 1975 | Crab Meat, Solid Packed |
| IS 8076 | 2000 | Frozen Cuttlefish and Squid |
| IS 9808 | 1981 | Fish Protein Concentrate |
| IS 10059 | 1981 | Edible Fish Powder |
| IS 10760 | 1983 | Mussels Canned in Oil |
| IS 10762 | 1983 | Tuna Canned in Curry |
| IS 10763 | 1983 | Frozen Minced Fish Meat |
| IS 11427 | 2001 | Fish and Fisheries Products - Sampling |
| IS 14513 | 1998 | Beche-de-mer |
| IS 14514 | 1998 | Clam Meat - Frozen |
| IS 14515 | 1998 | Fish Pickles |
| IS 14516 | 1998 | Cured fish and fisheries products - Processing and storage - Code of Practice |
| IS 14517 | 1998 | Fish Processing Industry - Water and Ice - Technical Requirements |
| IS 14520 | 1998 | Fish Industry - Operational Cleanliness and layout of market - Guidelines (Amalgamated Revision of IS 5735, 7581 and 8082) |
| IS 14890 | 2001 | Sardines - Fresh, Frozen and Canned (Amalgamated revision of IS 2421, 6677,8652,8653, 9750 and 10761 |

| | | |
|---|---|---|
| 4891 | 2001 | Mackerel - Fresh, Frozen and Canned (Amalgamated Revision of IS 2420, 3849,6032, 6033 and 9312) |
| IS 14892 | 2000 | Threadfin - Fresh and Frozen |
| IS 14949 | 2001 | Accelerated Freeze Dried Prawns (Shrimps) (Amalgamated revision of IS 4781 and 4796 |
| IS 14950 | 2001 | Fish - Dried and Dry-Salted |

Food Safety and Standards Authority of India (FSSAI)

The Food Safety and Standards Authority of India was established under the Food Safety and Standards Act, 2006 as a statutory body for laying down science based standards for articles of food and regulating manufacturing, processing, distribution, sale and import of food so as to ensure safe and wholesome food for human consumption. Various central acts including the erstwhile Prevention of Food Adulteration Act (1954) were merged under this act

The Food Safety and Standards Regulations (FSSR) came into force in 2011, which is divided to following sections:

- FSS (Licensing and Registration of Food businesses) regulation, 2011
- FSS (Packaging and Labelling) regulation, 2011
- FSS (Food product standards and Food Additives) regulation, 2011 (part I)
- FSS (Food product standards and food additives) regulation, 2011 (part II)
- FSS (Prohibition and Restriction on sales) regulation, 2011
- FSS (contaminants, toxins and residues) regulation, 2011
- FSS (Laboratory and sampling analysis) regulation, 2011

Recently, standards related to microbiological specifications of fish and fishery products, limit of heavy metals, PAH, PCBs and biotoxins have been incorporated in the FSSR.

## Chapter 15

**Labour in fisheries: Issues & Challenges**

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### Introduction

Fisheries and aquaculture have important roles in providing employment to millions of people in the world. FAO estimates that about 10-12% of the world's population may be employed in these sectors and 60 million people are directly and about 140 million people otherwise employed along the fisheries value chain (FAO, 2016). Fish is also one of the most traded commodities globally, most of it from the developing to the developed world (Gopal et. al., 2003; Gopal, 2010).

Fisheries and aquaculture are agri-food system with several inherent complexities. The act of harvesting the resource is one, and probably the most crucial, part of the value chain and can be either capture or culture (Fig. 1). Capture fisheries can again be classified as marine or inland depending on where the fishing is carried out. Inland fisheries are dependent on varied water bodies like rivers, lakes, reservoirs, ponds etc. (CPWF, 2013). Fishing in these waters can also vary in scale of technologies used and in the purpose for which the activity is carried out, using minimum or sophisticated technologies; artisanal or commercial; for meeting household nutritional needs or for generating incomes. Fisheries is also complex with respect to the multi-species targeted and the craft-gear combinations used for fishing. Aquaculture also has different variations depending on the type of culture resource – freshwater or brackishwater, organisms being cultured and the type of culture practiced – extensive or intensive. Fisheries also tends to be closely related to the seasonality of availability of resources being targeted. Besides the fisheries value chain has other pre and post harvest activities (Fig 2). Pre-harvest activities include arranging for supplies required for fishing and culture, fishing vessel fabrication, net making, aerators and other implements for culture etc. Post harvest activities include all activities right from the time the fish is landed to the sorting, grading, cleaning, pre-processing, processing, marketing, drying, smoking, salting and several other ancillary or supporting functions like auctioning, storage, transportation etc (FAO/ILO, 2013.

The multiplicity and informality of functions and functionaries, means that the labour in the sector is also as diverse as the sector is, and so are the issues and challenges. The wage sharing arrangements are generally based on word of mouth agreements. Underemployment in the sector is common, especially in fishing (Dhiju et. al., 2012). In the processing sector, wages are based on piece rate methods and can be exploitative.

Conditions of work in the sector are also extremely difficult and hazardous (Krishna et. al., 2002, Gopal et. al., 2009)).

Migration is another issue that is increasingly being seen in fisheries. Women migrant workers were always the backbone of the processing industry, but migration is also being observed in fishing sector, especially marine capture fisheries. Regulations are difficult to enforce and in several instances weak. Fishers and fisher communities have has traditional modes of control and regulation of access to resources. These have all but broken down and with changing technologies for fishing and change in motives of fishing these traditional structures are changing and new ones evolving (Gopal et. al., 2014). Associations are now common in marine fisheries sector and other ancillary and support services, but still largely unseen or poorly developed in inland fisheries.

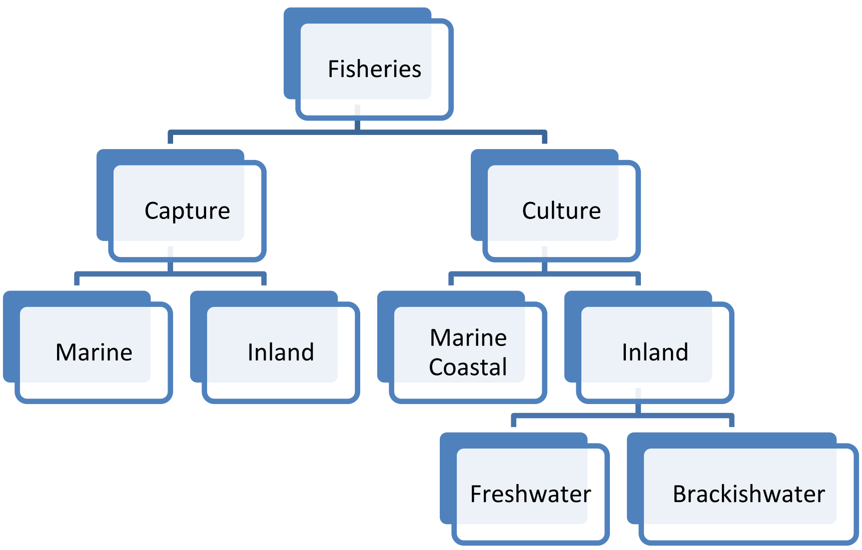


*Fig. 1: Harvest sector- overview*


*Fig. 2: Generic Value Chain*

This communication looks at labour in the marine fisheries value chain.

Employment in fisheries and aquaculture

Table 1 provides a picture of the employment status in world fisheries. Out of 58.3 million fishers, 21 million work in the inland, 18.4 million in the marine capture fisheries and 18.9 million in aquaculture. Of these 36% are full time, 23% apart time and 41% occasional fishers.

Table 1: Employment in fisheries and aquaculture (world)

| Marine capture fisheries | Inland water capture fisheries | Aquaculture | Total |
|---|---|---|---|
| 18.4 million (32%) | 21 million (36%) | 18.9 million (32%) | 58.3 million (100%) |

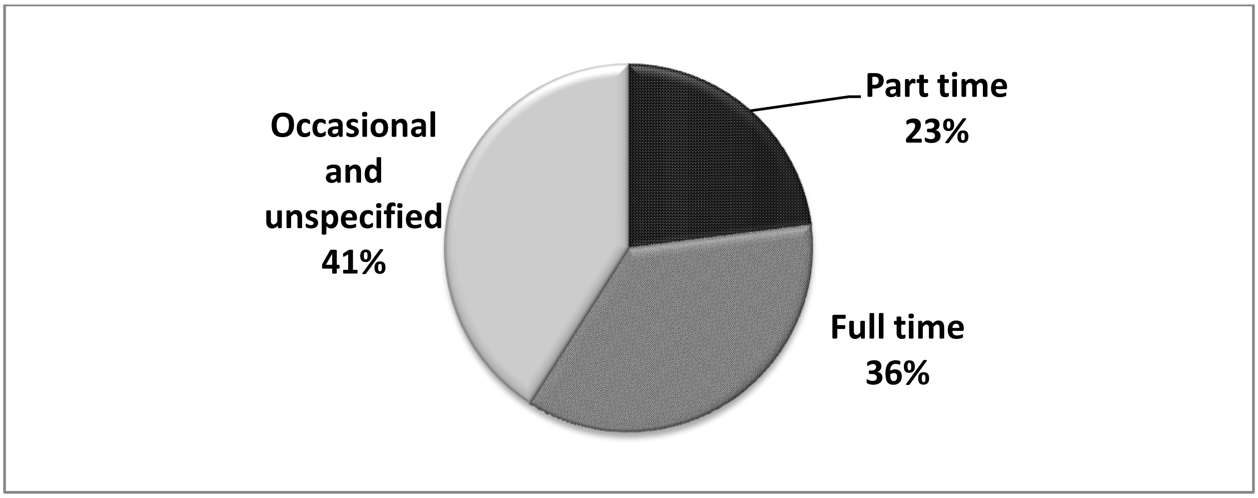


*Fig. 3: Full time, part time and occasional fishers in the world (%)*

In India of a total employment of about 14 million people in the fisheries sector, 3.5 million are directly dependent. Workers in the sector can be broadly classified as people engaged in land based/ shore based activities and those that are directly involved in fishing activities. While people engaged in fishing (who are directly engaged in capturing fish) are generally called fishers, fish workers include persons engaged in all other ancillary activities that take place within harbours, in landing centres or in close proximity of the fishing villages. They activities include (but are not limited to) the following:

- boat construction and maintenance
- maintenance of engines
- net making and mending (in artisanal fisheries much of the net making and mending is done by fishers themselves)
- ice production and supply
- loading and unloading
- Sorting, grading, weighing, icing, packing
- Transporting
- Auctioning
- Traders – wholesale, retail, headload

Some of the activities also take place at markets which can be located in other places away from landing centre/ harbours:

- Ice production and supply
- loading and unloading
- Sorting, grading, weighing, icing, packing

- Transporting
- Auctioning (at several nodes depending on the length of the marketing channel)
- Traders – wholesale, retail, headload

Fish processing is another major post harvest activity and will involve multiple activities:

- Gutting and cleaning (for domestic markets)
- Pre-processing (for further processing)
- Processing (in factories for export)
- Drying, salting curing, smoking (largely traditional, catering to domestic markets)

**International Covenants**

Access to decent forms and conditions of employment are enshrined in the Sustainable Development Goals. SDG8 is on 'Decent work and economic growth'. This was, among other things, necessitated because of '…..widening inequalities, and not enough jobs to keep up with a growing labour force.' The targets specifically mentions 'decent job creation' and '…. achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value' (http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-8-decent-work-and-economic-growth.html).

The ILO has set out the core labour standards (https://www.ilo.org) that are applicable in all employment situations. They are as follows:

- Freedom of association and the effective recognition of the right to collective bargaining (Convention No. 87 & No. 98)
- The elimination of all forms of forced and compulsory labour (Convention No. 29 & No. 105)
- The effective abolition of child labour (Convention No. 138 & No. 182)
- The elimination of discrimination in respect of employment and occupation (Convention No. 100 & No. 111)

With special reference to fisheries, concerned specifically with work on board fishing vessels is the Work in Fishing Convention, 2007 (No. 188).The Committee on Fisheries (COFI) of the FAO has also in its various Sessions decided on '…..legally mandated rights to decent working conditions…..' and '…..give priority to ensure decent working and living conditions in small scale fisheries……….' (http://www.fao.org/3/a-i5980e.pdf).

The four pillars of decent work are;

| | | | |
|---|---|---|---|
| **Employment & Enterprise** Development Availability of an adequate number of productive, quality jobs, which provide income to cover atleast basic needs | **Social protection** Protection from work-related injury and from lack of income due to | **Standards & Rights at Work** Fundamental rights: Freedom of choice & equality of treatment, | **Governance & Social dialogue** Participation to decision-making about work conditions and |

Source:http://www.fao.org/3/a-i5980e.pdf

Challenges and Issues

Keeping the various international covenants in mind as well as the various state specific policies and programs, the issues and challenges in the sector can be assessed.

***Fishermen on board***

While the ILO has specifically looked at conditions on board, we still find that in most cases the problems still continue to persist. Fishing is considered one of the most hazardous jobs in the world. Traditionally fishermen went with no safety equipment ad depended on their knowledge of the seas to navigate and fish. Fishing has improved technologically with mechanization. However conditions onboard continue to remain the same. Lack of safety equipment, poor onboard basic facilities for crew engaged in fishing are common. There is risk of injury considering the type of jobs to be done during fishing, including risks of cuts and injuries due to falls. States are insisting on carrying proper safety equipment onboard due to increasing frequency of disasters. However, unless it is linked with the registration process this may be difficult to implement. It is additional expenditure and vessel owners have to either be incentivized or mandated to upgrade facilities. Migrant labour is increasingly a part of fisheries and they face exploitation of other kinds, including wage related inequalities.

*Fish workers in harbours/ landing centres*

Landing centres and harbours are places where there is constant use of water and ice. This is the major risk with possibility of slipping and falling common. Proper protective gear, which is also essential for proper handling of the fish, is important. Other facilities for the functionaries in landing centers and harbours, like proper sanitation facilities also are important.

*Fish workers in marketing*

Marketing of fish is another important economic activity in fisheries value chain. Marketing can be done in harbours, in designated markets or door-to-door. Designated markets are generally poorly maintained and have all the issues that were discussed in the previous section. Wet, slippery floors, poor sanitation facilities, improper lighting and air circulation, cramped spaces are a few problems encountered by workers. Continuous squatting or standing also take a toll on health of these functionaries.

*Fish processing workers (traditional)*

Traditional fish processing work includes drying, curing, smoking etc. These are generally carried out outdoors. Sun burns, eye problems (especially in smoking), posture related issues due to continuous squatting or being on the feet are common. Continuous inhalation of smoke also leads to respiratory issues.

***Fish processing workers (factory based)***

Fish processing is an organised activity and it supports the export trade in fish and fishery products. The workers at the floor level work in very difficult conditions, standing for several hours in wet and cold conditions. Health checkups are mandatory for workers. There may be injuries to the palms and fingers as they are constantly in touch with water and ice. Constant standing also results in other conditions like back and other problems (Gopal et. al., 2007; Jeyanthi et. al., 2015; Gopal et. al., 2016).

**Conclusion**

The issues associated with labour working in the different nodes of the fisheries value chain have been existent since the time fishing has been an avocation. While there are are several international and national laws addressing labour issues, the on the sector level policy formulation and program implementation need to be strengthened to ensure safe and decent work and working conditions for fishers and fish workers.

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# Chapter 16

## Improving data quality for effective knowledge management in fisheries

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### Background

Fisheries in general, marine fisheries in particular revolve around a resource which is natural mostly self propagating and self sustaining, which re eminently prone to vagaries of various anthropogenic and climatic factors. Though this the template of dynamics for other natural resources too, the challenge as regards fisheries lies in the proper adjudication of factors and their extent of influence. These efforts can be mind boggling mostly and are ever resilient due to the reason that the level of predictability is low even in medium term. Fisheries like other resources are depicted by an array of numbers, data, under standard frameworks. They can be easily juxtaposed with climatic, oceanographic and anthropogenic factors with similar granularity. But the challenge starts only then. To conceive the paradigms of influence of climatic factors on fisheries is totally different from the set of models which one would be toying with to link oceanographic causes. The cause-effect relation between anthropogenic effects, mainly the fishing efforts, are totally distinct from the other two to zero in on a link function. Known modelling templates give way to lot of opportunity and challenges with respect to tweaking when it comes to explaining the phenomena exhibited by marine fisheries.

The growth of the animals has two levels of enhancement, one at individual level and the second at a stock or group or niche level. These two enhancements involve intricate biologically unique set of processes like addition in biomass by increase in size, by recruitment and loss in biomass owing to various kinds of mortality and lack of food availability. Such processes are different at different stages of the animals, starting from egg, larval to juvenile before recruitment into the fishery and then as adult and then as gravid animals. All these stages are affected by various factors of biotic and abiotic in nature and also get overwhelmingly impacted by single dominant threshold factors too. To complete the complexity of the intricate dynamics a shrouding pall of thick sheet of water envelops the whole set of dynamics, which makes palpable information near impossible. Analysing the second stage, treating the geo-spatial area stock as the limiting factor and treating similar animals (same species) as a bunch of self sustaining yet competing individuals, the factors like intrinsic rate of growth in numbers of the species in the stock and the spatial limitation of the defining habitat are used as the deciding factors of getting a palpable assessment of the strength of the resource’s presence. As one can easily understand this type of postulation is never complete as many extraneous factors that either limit the spatial/ food availability by means of vying for the same base and those that define the primary productivity or the plankton availability of the zone under focus are possible additions to these models. To summarize the fisheries information dynamics gives less while taxing more as regards evolving into knowledge which is consistent and generic. So needless to say, knowledge management in such situations are a challenge of higher order and on the flip side are quite handy if successfully performed. In this discussion the focus would be on possibilities and issues of knowledge management (KM) in fisheries, mostly marine fisheries.

**What is KM?**

KM as its linguistic ramification leads to is about putting the organized information on any subject or resource to more proper utilization than mere summarization in such a way as to hidden paradigms emerge. Data mining too falls under this purview. Uncovering hidden patterns and relisting causes with the addition of latent ones form the basic tenets of this facet of knowledge management. But to understand this better the basic requirement would be a huge data pool of organized or unorganized in nature pertaining to any given subject or resource. Thus a collated platform of different types of measurable and processable data is the starting point for knowledge management. To cite Bruce Mathew et al (2014) KM represents a deliberate and systematic approach to ensure the full utilization of the organization‘s knowledge base, coupled with the potential of individual skills, competencies, thoughts, innovations, and ideas to create a more efficient and effective organization.

Knowledge, simply put, is a collection of personalized view points pertaining to any subject. It is a sort of opinionated data base on any facet of the product or subject under review. Hence such knowledge can be tacit, which is intrinsic and demands more effort to be located, and explicit, which is a sort of ready to use type. Tacit knowledge if strong in its adaptability orientation while explicit knowledge is quite useful in its training and exhibiting orientation. Each has its own inherent strength and weakness, which when properly treated would lead to better utilization of the hybrid vigor. KM is managing the corporation's knowledge through a systematically and organizationally specified process for acquiring, organizing, sustaining, applying, sharing and renewing both thetacitandexplicit knowledgeof employeesto enhance organizational performance and create value (Davenport and Prusak, 2000).Knowledge management is about applying the collective knowledge of the entire workforce to achieve specific organizational goals. The aim of knowledge management is not necessarily to manage all knowledge, just the knowledge that is most important to the organization. It is about confirming that people have the knowledge they need, where they need it, when they need it – the right knowledge, in the right place, at the right time.

With this as background fishery managers and researchers can treat the accumulated wealth of information available as a starting point for KM. There are quite a few established tools in the realms of KM, which can be put to good use for zeroing in on the right and correct knowledge at the right occasion. The following case study elaborates the application of Rough Set Theory in predicting or assessing the factual dynamics of one of the most important marine fishery resources of South West India, Indian Oil Sardine, *Sardinellalongiceps* (Val.). It was carried out while mining four years of catch/ catch rates recorded at the landing centres of Kerala state of South Western Indian peninsula and factoring them alongside six climatic variants viz. Sea Surface Temperature, Relative Humidity, Atmospheric Temperature, Meridional wind, Sea Level Pressure and Total cloudiness. Using the local covering, rule mining and reducts, which are the analytical arms of Rough Set Theory, a significant subset of combination of attributes with discretised ranges was carved out from the plethora of combinations. The pre-processing of datasets was performed by using R and the analysis by ROSE2 (Rough Sets Data Explorer). In all 33 rules were churned out, which when explained turned out to be as simple as stating “if SST falls in the range 28.75956 to 28.92879, and SLP falls in the range 1007.252 -1008.006, then total catch will be in the range 2968.5 to 6763.9 tons”. Such “what if” scenarios can lead to better quality of knowledge and thus can aid inbetter management of fisheries.

**Other tools to fish out tangible inference**

Apart from these nonconventional means using argumentative alternatives by treating the datasets as totally unorganised array, there are tools to treat them as organised or semi organised array of smoothly behaving realisations of well defined populations. These are collectively referred to as data mining tools. The most prominent amongst them are Artificial Neural Networking (ANN), Decision trees (Chi Squared Automatic Interaction Depetector (CHAID)) etc. There are instances in fisheries domain where prediction of resource abundance has been attempted by popular engineering tools like wavelet theory and fuzzy regression. All these indicate the sufficiency of data wealth, however unorganised, they are which is why these many tools which are formal and quasi-formal are being applied for forecasting and decision making at various degrees of success.

Another major branch of inferential analysis is the Bayesian mode of inference. With most of the sub processes in the life cycle of fish well identified the undercurrents can be modelled and those prior defined models can be incorporated to analyse the realised datasets with added efficiency. With the explosion in the computational prowess of an average researcher leapfrogging to astronomical proportions, the application of any sort of deductive tool gets too easy in terms of operationalisation.

**Quality of data**

Riding upon the wave of computational rigours and tools, the most unexpected challenge faced by a researcher is strangely bringing him back to basics. How good is the data? For once the data is available in a portable and scalable digital format a myriad of opportunities are listed in literature to treat them as formal numeric data, ordinal data or even nominal information with parametric and nonparametric treatments with the souls aim of arriving at an inference. But as it can be easily proven information is data deep. It can say more than what has been realised in numbers. But inference can be woven based on intrinsic and extraneous measures related to the information. But in the steady phase even that need proper updating to match the progress of time and its impact on systemic processes. Thus it becomes equally or rather more important to assure quality of data. This may sound odd in these days Internet of Things (IoT), but true it is. The groundswell is important but the aquifers are more important.

In fisheries it is all the more sacrosanct. It can be seen by simple review of literature, that fishery inferences, especially on the population inference like biological reference points (BRP), which are managers’ gospel, keep fluctuating from time to time with impunity. One of the most famous BRP, Maximum Sustainable Yield (MSY) is the test case. Its variability is so unique and permanent that with stock, location and year it is destined to change. That which is supposed to help managers in taking a call on the future interventions to conserve and make the fishery sustainable, itself keep changing the goalposts. Probably less known in other fields. So precise and that too consistently precise data collection is the bedrock of such vital parameter computations. So any method which is immediately lapped up for being listed as a “data deficient situation tool” is wrought with lots of risks in fisheries. We may come across works publicizing themselves as simply catch based with no support of effort to have been measured parallelly with catch, need to be opted as last resort.

For catch rates that too from unbiased cruises are the basic building blocks of any inference on the status of marine fishery resources. The only possible exemption permitted could be to consider commercial catches and landings instead of random cruises. Dilution of these any further will make the inference circumspect and management highly inefficient. So on a macro scale there is a minimum requirement of getting a correct measure of catch rate or quantity of a resource caught per unit effort or per boat is mandatory.

**Sampling methods to improve data quality**

After underlining the quality of basic data be it catch or effort or anything down the granularity as size spectrum of the resources etc., it is the prerogative of any planner to suggest ways and means of collecting such information. In marine fisheries by far the most efficient and successful method to estimate catch rate is to go for sampling of the fisheries process at various stages and collating the unbiased collection of datasets for further analysis and inference. As a classic situation we may consider the catch and effort estimation procedure being followed by Indian Council of Agricultural Research- Central Marine Fisheries Research Institute (ICAR-CMFRI) as detailed in Srinath et al.(2005) Here the fishing operation is treated as an incessant process occurring throughout the day for all the days in a year carried out by multiple types of crafts and gears, targeting a few commercial resources.

Usually and sample survey plan would have properly defined populations and the attributes that are required to be estimated termed as parameters. They are estimated by statistics, which are realisations from the appropriate samples. As per statistical ethics, the sample must have the impartiality enshrined by means of application of randomness at some level. The other aspect of a proper sample is in its being the most representative of the population under consideration. So naturally when we attempt to measure catch/ landings and efforts in a fishery during a period the following define the population.

1. Geographic area/ zone
2. Duration/ period
3. Gear/ craft or a combination

And

4. the species/ resource under focus

As per ICAR-CMFRI methodology, which has won plaudits from FAO and other peer organisations, the population is defined as a zonal month for a particular gear and species. For example it could be the total landings/ effort expended for zone-1 (district equivalent) of Kerala state for the month of October, 2017 pertaining to Oil sardine using Ring net gear. Now once the population is defined the sampling frame needs to be listed unambiguously. As per the structure of fish landing centres/ harbours in India, a list of identified distinct and exhaustive list of such places are collated zone/ districtwise. The centres are then grouped into two to three homogenous classes based on the intensity and variety of fishing prevalent there called as strata. The calendar month is then divided into three sequences of ten days interregnum each to ensure that the lunar and sub-seasonal variations in fish availability get offset. Then as a basic first stage unit of a typical sample the landing centre- day is identified. It signifies a 24 hours period at a selected landing point of a given stratum. Thus depending upon the workforce and the strata, invariably at least two landing centre days are selected for each stratum in a zone- month. The 24 hours are selected in such a way as to maximise the possibility of first hand observation of fish landings by the enumerator. Traditionally these happen mostly during day time either early morning or near twilight, and hence an enumerator is instructed to cover a landing centre from 12 noon of the first day to 12 noon of the subsequent day with 12 hours of direct observation in two spells viz. 1200- 1800 hrs and 0600 hrs- 1200 noon. The details of interceding night's landing are then recorded by enquiring those present in the centre the next day. Thus the statistical one landing centre day gets covered. These three spells, called sessions in a landing centre day are followed up by second level of sampling which involves random selection of at least two crafts of a particular gear-type totalling to around 10- 15 per session.

The randomness of selection of the landing centre days equally spread over the three ten day interregnums and the 10-15 boats selected in a session follow a random start followed by systematic picking suiting the size of landings subsequently. Technically it can be seen here that sampling occurs at two levels, first at landing centre day level and the second at the craft selection level and this happens within each stratum of each zone (district) for every month. Hence this falls under the generic category of stratified multistage (two stage) random sampling whereby using appropriate scaling or raising factors the catch/ landings for each population unit viz, zone- month is estimated. Parallelly estimated is the corresponding dosage of effort expended too. Combining these two with suitable standardization usually results in catch rate, which is the starting point in any study of resource abundance as traditionally biomass availability or otherwise are strategically equated to the catch per unit effort of an average fishing craft on an average day. Thus ICAR-CMFRI has a long time series of such scientifically planned and systematically executed time series of catch and effort right from its inception in late 1940s.

**Advanced methods enhanced precision**

With the advent of new fishing methods and the direct impact that markets exert, these kinds of sample survey methodologies need constant review and update. As it can be seen from the basic method described in previous section, gear is one of the deciding features of a population. But as it is well known, the gears are no more unique with different shades of the generic type reflecting the innovative evolutions of the fishermen in a semi-controlled environment like that of Indian waters. Also unattributed is the days out on sea. With fishing spans topping over a month the units samples no more represent the traditional single day unit. Hence these may have to be inculcated into the survey procedure or at least in the estimation. Hence the options like two phase sampling, hybrid estimation and post-stratification approach are quite relevant in this fast-changing multi-gear multi- species scenario.

The two-phase sampling has an approach of double sampling, the first one to estimate a parameter hitherto assumed to be precisely known, like total number of gears of a kind in a stratum and their frequency during the ten-day interval, while the second one aims at selection of landing centre days suitable to measure the dynamics associated with the gear. The fishery, as is now being practiced in India, is quite dynamic in terms of targeted resources and the collateral by-catch turning out to be regular fishery. That too this remaining in a state of constant flux, with by catch fishery being interchanged with core fishery, is quite a challenge to design a sample survey. Thus, in such situations the two phase sampling/ two time sampling can come in handy.

The second option is to have samples post-stratified for resource groups post selection, as in many cases the resource specific targeting does not exist and the collateral catches are too voluminous and significant to ignore. But this needs a very careful planning as these strata are supposed to be flexible but at times overlapping, resulting in over or under estimation of catch and effort. Hybrid estimators are one of the most practical alternatives to improve quality of estimators without enhancing the sample coverage or adopting complex designs. This involves collation estimates of standard peer establishments and arriving at a validation-based penalty to combine all of them into ones. In other words, this could be termed as a survey of surveys.

**To conclude**

While knowledge management has ways and means to exhaustively revise the traditional expertise available in fisheries, the success of any such tool depends on the precision of their roots, data collected. Hence the best foot forward for a sound fisheries management is to buttress its data collection mechanism, right from enumerator selection to sampling design and estimation and adoption of suitable KM tools or mining analytics for better guided exploration and inference of the population under study.

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## Chapter 17

**Initiatives and issues in fishery sector development**
**Successful experiences of kvk**

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### Introduction

Indian Council of Agricultural Research mooted the idea of establishing Krishi Vigyan Kendra's to conduct "On Farm Testing" for identifying technologies in terms of location specific sustainable land use systems, to Organise "Front Line Demonstrations" to establish its production potentials on the farmers' fields and to generate production data and feed back information, conduct "Trainnings" for farmers to update their knowledge and skills in modern agricultural technologies, training of extension personnel to orient them in the frontier areas of technology development on regular basis, to arrange "Vocational Trainings" both long and short term for the farmers, rural youth and women with emphasis on' learning by doing' for higher production on farms and generating self employment and various "Extension Activities" in order to speed up the process of dissemination of technologies.

Krishi Vigyan Kendra (Ernakulam) functioning under Central Marine Fisheries Research Institute (ICAR) aims at the overall development of the district in agriculture and allied sectors. The Kendra has linkages with all the line departments in the district in addition to contacts with most of the Agricultural Universities and all the ICAR Institutes in the country. These linkages helps the Kendra updated on the recent technologies in agricultural and allied sectors. Highly qualified professionals in each fields of agriculture working with Kendra facilitate to modify these technologies suiting to local requirements by adopting various scientific methodologies. Thus locally viable technology takes birth. A successful technology would be popularized by the Kendra whereas feedback from a failure would be sent back to the research institutions for refinement. The impact of our technology dissemination activities is visible in the technology adoption and success rate by farmers.

**Traditional farmer turned fish seed entrepreneur**

Mr. Shibu C.V, Kocheri house, Kumbalangi South PO, Kochi-682 007, Ernakulam was a traditional farmer doing fish farming. His annual income was only INR 12,000/ per year. He approached KVK during 2013 for enhancing the income employing some innovative technology.

KVK team made a visit to his field and carried out water quality analysis and chalked out a plan to develop a suitable package of practice for improving income from his 40 cent pond. The water quality analysis revealed that the salinity in the pond fluctuates from 0 ppt (during July) to 28 ppt (during April). This is ideal for farming /rearing euryhaline species such as Pearlspot, Mullet, Asian Seabass, etc., The team arrived at a conclusion that normal grow out fish/shrimp farming is not ideal practice for a full time farmer utilizing such a small unit area. Hence KVK proposed "*Pearl spot seed production and marketing*" programme in the said 40 cent pond area. Subsequently KVK provided hands on training on Seed production of Pearl spot during 2013-14 period. During 2014-15, KVK selected him as a partner farmer for conducting FLD "Breeding and seed production of pearl spot in pond systems" and successfully demonstrated accelerated Pearl spot seed production protocol. KVK provided critical inputs for establishing fish seed acclimatizing and packing facility. KVK prepared and provided leaflets describing acclimatization procedure for him to supply to farmers along with the packed seed bags.

In addition, KVK also chalked out plan to use 50 cent land area near the said pond for organic vegetable farming. I this connection demonstration on Palak variety Harith Shoba and bacterial wilt resistant Tomato variety Arka Samrat of Tomato were carried out in his field. Fruit fly trap was also demonstrated in this vegetable farm. Subsequently his farm was developed as an integrated farming system model by demonstrating Kadakknath poultry rearing.

Launching and marketing of the Pearl spot seed production unit was inaugurated by Kumbalangi Grama Panchayath President, Smt.Susan Joseph wide publicity was given in media. In addition KVK arranged to telecast a documentary about his seed production activities through DD Krishidarshan programme, which attracted attention of lakhs of viewers even across globe.The output details in terms of production and income from seed production, vegetables and Poultry are provided respectively in Tables 1, 2, 3 and total income in Table 4.

**Table 1. Average annual income from Pearl spot seed production**

| **Sl No** | **Year** | **Seed Produced (Nos.)** | **Price per seed (Rs.)** | **Gross cost (Rs.)** | **Gross income (Rs.)** | **Net income (Rs.)** | **BC ratio** |
|---|---|---|---|---|---|---|---|
| 1. | 2013-14 | 14,000 | 10 | 58,500 | 1,40,000 | 81,500 | 2.4 |
| 2. | 2014-15 | 18,000 | 10 | 50,000 | 1,80,000 | 1,30,000 | 3.6 |
| 3. | 2015-16 | 20,000 | 10 | 50,200 | 2,00,000 | 1,49,800 | 3.9 |
| 4. | 2016-17 | 25,000 | 10 | 50,700 | 2,50,000 | 1,99,300 | 4.9 |

**Table 2. Average annual income from vegetable farming**

| **Sl No** | **Year** | **Veg produced (Kg)** | **Price per Kg/-** | **Gross cost (Rs.)** | **Gross income (Rs.)** | **Net income (Rs.)** | **BC ratio** |
|---|---|---|---|---|---|---|---|
| 1. | 2013-14 | 150 | 30 | 1,500 | 4,500 | 3,000 | 3.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2. | 2014-15 | 250 | 30 | 2,000 | 7,500 | 5,500 | 3.8 |
| 3. | 2015-16 | 350 | 30 | 3,500 | 10,500 | 7,000 | 3.0 |
| 4. | 2016-17 | 425 | 30 | 3,600 | 12,750 | 9,150 | 3.5 |

**Table 3. Average annual income from Poultry (egg and meat)**

| **Sl No** | **Year** | **Gross cost (Rs.)** | **Gross income (meat and egg) (Rs.)** | **Net income (Rs.)** | **BC ratio** |
|---|---|---|---|---|---|
| 1. | 2013-14 | 14,000 | 22,500 | 8,500 | 1.6 |
| 2. | 2014-15 | 10,000 | 29,500 | 19,500 | 3.0 |
| 3. | 2015-16 | 16,500 | 23,600 | 7,100 | 1.4 |
| 4. | 2016-17 | 17,500 | 21,500 | 4,000 | 1.2 |

**Table 4. Total Income**

| **Sl No** | **Year** | **Net income (Rs.)** |
|---|---|---|
| 1. | 2013-14 | 93,000 |
| 2. | 2014-15 | 155,000 |
| 3. | 2015-16 | 163,900 |
| 4. | 2016-17 | 212,450 |

Average annual income of the farmer increased successively from Rs.12,000/- (during 2012-13) to Rs.2,12,450/- during 2016-17 period.

Seeing the success of Pearl spot seed production initiative National Fisheries Development Board (NFDB) sanctioned a project with an outlay Rs.12, 85,000/- to KVK to popularize this technology through their Technology Up-gradation Research Project (TUP). Under this scheme six similar Pearl spot seed production units were also developed in the district.

**Traditional fisherman turned aquapreuneur**

Shri.Ambrose Thommissery was a traditional fisherman till October 2012. He earns hardly INR 20,000/- per annum from his 0.80 acre brackish water pond coupled with fishing in local water bodies. He was striving to manage his family of four.

KVK intervened and trained him in scientific Mullet (Mugilcephalus) fish farming in his pond. The fish reached average length of 35 cm and weight of 520 gm with 80% survival rate whereas the conventional farmers get a survival percent of 10-30% only. Live caught fish were marketed at farm gate itself. It was a great success due to high domestic demand for the live farm fresh fish. This process also avoided the intervention of middle men and fetched maximum price higher than the prevailing retail market price. Following the success of the demonstration, other traditional farmers in the locale have come forward for replicating scientific mullet farming programme during the next season using own funds. The total expenditure was INR 44,500/- . A total of 500 kg fish was harvested and sold at the rate of INR 500/- per Kg fetching a total income of INR 2.5

lakhs. Shri. Ambrose has already kept aside INR 50,000/- for continuing the farming in the next season.

**Integration of fin fish culture with paddy-shrimp farming in pokkali field doubled the income of mr.saigal, an young farmer**

Pokkali is a typical farming system in Ernakulam district in which saline tolerant paddy and shrimp are alternatively cultured in the same field where salinities range from 0 to 28 ppt depending on climate. The biomass residues of the paddy crop form the feed base for the shrimps and the residues of the shrimp culture acts as a fertilizer for paddy and hence the symbiotic system can be referred to as "Zero Input" organic farming system. Pokkali farming received GI of Govt. of India and also Plant genome saviour community award of PPV&FRA, New Delhi recently.

A package was developed for pokkali fields by KVK with funding from National Initiative on Climate Resilient Agriculture (NICRA) to increase the income from unit area by integrating high value finfish farming in cages. Mr. Saibil AR (AnjilHouse ,Ezhikara PO, Ph No:9809051168 ) a young farmer from Ezhikkara readily agreed for this new experiment in his Pokkali field. The KVK team trained him in Pond preparation, cat walk construction, cage construction, nursery rearing, fish transportation, feeding, cage maintenance, etc., in well advance to the implementation of the programme. Nursery reared Mullet (Mugilcephalus) and Pearlspot (EtroplusSuratensis) were stocked in cages during 1st week of September. The initial stocking density of mullet was 250 nos. per cage and that of Pearl spot was 500 nos. per cage. They were fed using floating formulated pellet feeds of different size (2mm, 3mm, 4mm) during dawn and dusk. Cages were cleaned fortnightly and nets were changed once in two months period. Thinning out was done depending on the growth rate. The culture continued for 8 months. The mullet attained average size of 400 gm with survival of 60 per cent and Pearlspot 180 gm with a survival of 90 per cent.

The fixed cost invested for the cage culture in Saibil's 1 ha pokkali fields was INR 88,200/-. Since the assets can be used for 5 years, the fixed cost per year would be INR 17,640/-. The operational cost per year was INR 90,000/-. The gross income per year he got was INR 1,90,000/- and the profit per year was INR 83,000/-. Mr.Saibil was getting a profit of INR 15,000 from paddy crop alone and INR 50,000 only from combined paddy and shrimp cultivation from 1 ha field before KVK's intervention.

**Innovative initiative for enhancing inland fish production utilizing granite quarries**

Inland fish resources are undergoing depletion day by day due to anthropogenic interventions such as sand mining, hydroelectric projects, unscientific sewage disposal, destructive fishing practices etc and also due to impact of climate change such as salinization, floods, etc. Promotion of Aquaculture using hatchery produced seed is the only viable alternative for reducing the fishing pressure on the indigenous species and also for addressing the ever increasing demand of fish protein towards human nutritional security. Suitability and sufficiency of area are main constraints for promoting fish culture in inland areas. More than 6000 granite quarries exist in the foot hills of Western Ghats, the longest mountain range of Southern India. These perennial fresh water reservoirs are optimum for initiating fish culture whereas normal farming methods are not viable due to the depth ranging from 10 to 60 meters. With a view to utilize these resources, a cage fish culture model was developed and demonstrated in partnership with a traditional farmer. Small floating cages made using HDPE nets and PVC pipes were erected in the quarry. Locally preferred fish species Pearl spot, Tilapia and Pangasius were cultured in cages. Average production from one cage was 130 to 150 Kg and the farmer received a net income of INR 14,300/-. One cent area can accommodate 7 such cages. The demonstration realized the practical viability of the model. This model can be widely adopted in granite quarries for enhancing fish production for livelihood and nutritional security in the region.

**Farm gate markets: an innovative approach for marketing quality fish at premium price**

Marketing is one of the main challenges faced by fish farmers. Farmers are forced to sell produce at low price due to perishable nature of fish and need of costly facilities for storage and transportation. Middlemen who have these facilities always get maximum profit with minimum effort. Unavailability of good quality fish is the main concern for the consumers though they are ready to pay premium price for quality products. In this context a concept called *Farm gate markets* was field tested to avoid middlemen and ensuring maximum profit for farmers while ensuring quality produce for consumers. This model was demonstrated in Pokkali paddy fields located in coastal areas of Ernakulam district in Kerala during the fish harvesting season in April month of 2014. Pearl spot (*Karimeen*) and Mullet (*Thirutha*) fish grown in pokkali paddy fields are known for their taste and quality. Having received Geographical Indication (GI) of Government of India, pokkali fields are synonymous with organic farming. Wide announcements where given to attract public and arrangements were made in the farm for public to see the harvest and buy live caught fish. The brand name Pokkali attracted fish consumers from nearby district also. A total of 350 Kg fish were sold at the rate of INR 500/- from 1 Acre Pokkali field. The farmer got a net income of INR 1.75 lakhs and 35 per cent additional profit through the new mechanism. This is a replicable model for Pokkali farming system which can also be suitably applied in any fields.

**Pokkali framers producer company ltd.**

Base line survey was conducted in different Pokkali farming area such as Kadamakkudy, Pizhala, Ezhikkara, paravur, Kumbalangi, Chelanam, Nayaramabalam, Edavanakkad, etc., in Ernakulam district. Pokkali farming is carried out either by individual farmers in their own / lease lands or by the farmers consortiums known as *Padashekara samithees*. In this case the owners get a lump sum amount as per the area, depending on auction amount. These Pokkali farmers and padasheghara samithees details were collected from the Krishibhavans of Agriculture department, Govt. of Kerala and created the data base. Thereafter they are invited for a discussion about the commencement of a farmer producer company for their benefit. In order to invite the attention of all farmers, a press release was also given in all leading Malayalam dailies.

NABARD accredited KVK as POPI and sanctioned financial assistance for establishing Pokkali FPO at Ernakulam district. Thereafter, Pokkali farmers meet was organized at ICAR CMFRI and explained the significance of farmer Producer Company. Hearing the new concept, fifty farmers came forward to join in the company. In order to mobile 5 lakh equity, share value for a single share was fixed of Rs.1000/-. Meeting elected ten farmers as board of directors and decided to give 500 shares to the Pokkali farmers. Eighty six Pokkali farmers joined in the company having a total of 236 shares (Rs.2.36 lakh).

First business plan developed for the FPO is the collection and marketing of Pokkali produce. In order to facilitate this activity KVK provided an exclusive trade mark "*JAIVAPOKKALI'* registered by KVK to the company.As part of this, FPO participated in the Agri-Aqua-Food fest and exhibition as part of the Second International SAFARI Symposium during 15th to 17th January 2018 at ICAR-CMFRI, Kochi. FPO introduced few products such as Pokkali Farmer producer company products such as Pokkali raw rice, Pokkali parboiled rice, Pokkali rice powder, Pokkali dried Shrimp, *etc* and studies the consumers response. Consumers are interested to purchase raw Pokkali rice rather than value added products.

The test marketing experience revealed that selling of pokkali produce alone may not give more benefits to the Pokkali farmers. Hence a new business plans to source and supply farming input developed and initiated steps to implement as early as possible.

**Traditional fisherman turned sea food entrepreneur**

Mr. Sukumaran, Moonnuthuruthil from Kodungallore aged 50 was a traditional fisherman doing prawn fishing and selling the catch daily in nearby markets for his livelihood. He holds the license for operating the traditional fish catching gear called "Oonnivala" at the Kottapuram backwaters. Most of these prawn are purchased by middleman for making dried prawn which have more demand in market. Fresh Prawn price in the market vary between INR70 to 100 per kilogram depending on the Season/climate. The catch will not fetch good price if the climate is cloudy or rainy. His monthly income during this time was INR 300.00. Due to price variation, he wanted to go for production of dried prawn and approached KVK during October 2012 for a better advice.

KVK team visited his place and advised to go for an electrical dryer for hygienic dried prawn production. It is worthwhile to note that most of the entrepreneurs go for sun drying or smoke drying of prawn. Mr.Sukumaran was given training on dry prawn production using electrical drier during 2012. He purchased a drier during 2012 and started dry prawn making from his own catch and started selling it to traders at the rate of INR 100.00 to 300.00 per kilogram. 4-5 kg of fresh prawn is required to produce 1 kg of dried prawn. His processing capacity was 60 kg of dried prawn per month. In this way he achieved income of INR 18000.00/- per month. Later on the KVK team identified that the dried prawn mainly goes for making value added products such as ready to cook dried prawn, prawn chutney powder and roasted prawn. In order to further increase the profit of Mr. Sukumaran, KVK gave training on manufacturing of these products during January 2013. KVK team also facilitated him to get Food Safety and Standards Authority of India (FSSAI) registration and a Small scale industry (SSI) registration. A brand name-KAYAL CHEMMEEN was finalized by KVK team in consultation with Mr.Sukumaran.

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# Chapter 18

**Ornamental fish keeping: History, status and prospects**

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## The History of Fish Keeping

Philip Henry Gosse (1810-1888) coined a term "Aquarium" which is now familiar to all of us, in his 1854 book *The aquarium: An unveiling of the wonders of the deep sea*.

The idea of keeping aquariums can be dated back to 2500 BC and has evolved into a complex hobby that exists today. Ancient Sumerians and Romans kept fish in containers as early as 2500 BC, similar to what we now know as fish tanks. These tanks were designed to keep fish alive long enough to prepare the specimen for food. It is also known that Romans and Babylonians kept ponds filled with fish for ornamental use (History of Fish Keeping as a Hobby).

As time progressed, the art of fish keeping became a "luxury for the rich" (DuHammel 1). Many people consider the Chinese as being the most important contributors to the hobby. "By 1136 AD Emperor Hiau-Tsung started to breed and keep these fish in a more controlled environment. Several new breeds of ornamental fish ornamental emerged." (DuHammel 1). As more people became involved in the idea of fish keeping, having a goldfish was no longer an indicator of a person's status. Many common people began to keep goldfish; the fish that they kept represented a good luck charm.

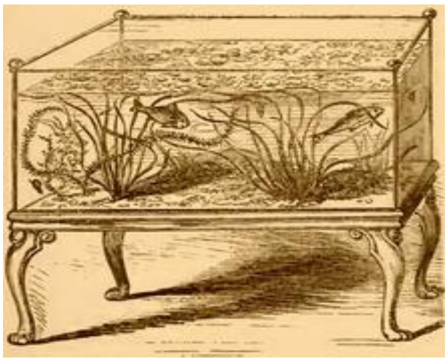
During the Sung Dynasty that lasted until 1279 AD, many people began to experiment with different ways to keep fish as pets. This group of people kept ornamental carp as decorative artifacts. The carp made their way into Europe during the 1600's. This is when the idea of keeping fish in small bowls came about. Expert Tullock quoted Samuel Pepys of the 17$^{th}$ century by saying, "Fish keeping in a bowl is seen as being exceedingly fine," which is still true today (History of Fish Keeping as a Hobby).

Until the 1800's aquarists did not fully understand how to keep their captive fish alive. This did not stop their efforts in keeping the underwater pets. People continued to research keeping fish in tanks and their methods slowly became more advanced. It was not until 1805 that people started to understand the idea of "cycling" a tank before putting fish in it. The cycling period is very important for the growth of needed bacteria that is essential to keep the captive fish alive. Robert Warrington was the founder of this idea, and it is so important that it is still used today. Since cycling enabled the fish to be kept alive for long periods of time, the idea of keeping fish spread worldwide.

In 1836, soon after his invention of the Wardian case, Dr. Nathaniel Bagshaw Ward proposed to use his tanks for tropical animals. In 1841 he did so, though only with aquatic plants and toy fish. However, he soon housed real animals. In 1838, Félix Dujardin noted owning a saltwater aquarium, though he did not use the term. In 1846, Anne Thynne maintained stony corals and seaweed for almost three years, and was credited as the creator of the first balanced marine aquarium in London. At about the same time, Robert Warington experimented with a 13-gallon container, which contained goldfish, eelgrass, and snails, creating one of the first stable aquaria. He published his findings in 1850 in the Chemical Society's journal.

Germans soon rivaled the British in their interest. In 1854, an anonymous author had two articles published about the saltwater aquaria of the United Kingdom: *Die Gartenlaube* (The Garden House) entitled *Der Ocean auf dem Tische* (The Ocean on the Table). However, in 1856, *Der See im Glase* (The Lake in a Glass) was published, discussing freshwater aquaria, which were much easier to maintain in landlocked areas. In 1862 William Alford Lloyd, then bankrupt because of the craze in England being over, moved to Grindel Dammthor, Hamburg, to supervise the installation of the circulating system and tanks at theHamburg Aquarium. During the 1870s, some of the first aquarist societies were appearing in Germany. The United States soon followed. Published in 1858, Henry D. Butler's *The Family Aquarium* was one of the first books written in the United States solely about the aquarium. According to the July issue of *The North American Review* of the same year, William Stimson may have owned some of the first functional aquaria, and had as many as seven or eight. The first aquarist society in the United States was founded in New York City in 1893, followed by others. The *New York Aquarium Journal*, first published in October 1876, is considered to be the world's first aquarium magazine.

By 1850 new equipment for the aquarium emerged. At that time they came to conclude that fish needed clean and warm water to survive. The keeping of fish in an aquarium became a popular hobby and spread quickly. In the United Kingdom, it became popular after ornate aquaria in cast-iron frames were featured at the Great Exhibition of 1851. In 1853, the first large public aquarium opened in the London Zoo and came to be known as the Fish House. Philip Henry Gosse was the first person to actually use the word "aquarium", opting for this term (instead of "aquatic vivarium" or "aqua-vivarium") in 1854. In this book, Gosse primarily discussed saltwater aquaria. In the 1850s, the aquarium became a fad in the United Kingdom. Tank designs and techniques for maintaining water quality were developed by Warington, later cooperating with Gosse until his critical review of the tank water composition. Edward Edwards developed these glass-fronted aquaria in his 1858 patent for a "dark-water-chamber slope-back tank", with water slowly circulating to a reservoir beneath.



An aquarium of the 1850s containing *Vallisneria spiralis* andcoldwater fish

In the Victorian era in the United Kingdom, a common design for the home aquarium was a glass front with the other sides made of wood (made watertight with a pitch coating). The bottom would be made of slate and heated from below. More advanced systems soon began to be introduced, along with tanks of glass in metal frames. During the latter half of the 19th century, a variety of aquarium designs were explored, such as hanging the aquarium on a wall, mounting it as part of a window, or even combining it with a birdcage.

Twentieth century

Around 1908, the first mechanical aquarium air pump was invented, powered by running water, instead of electricity. The introduction of the air pump into the hobby is considered by several historians of the hobby to be a pivotal moment in its development Aquaria became more widely popular as houses had an electricity supply after World War I. Electricity allowed artificial lighting, as well as aeration, filtration, and heating of the water. Initially, amateur aquarists kept native fish (with the exception of goldfish); the availability of exotic species from overseas further increased the popularity of the aquarium. Jugs made from a variety of materials were used to import fish from overseas, with a bicycle foot pump for aeration. Plastic shipping bags were introduced in the 1950s, making it easier to ship fish. The eventual availability of air freight allowed fish to be successfully imported from distant regions. In the 1960s, metal frames made marine aquaria almost impossible due to corrosion, but the development of tar and silicone sealant allowed the first all-glass aquaria made by Martin Horowitz in Los Angeles, CA. The frames remained, however, though purely for aesthetic reasons.

In the United States, as of 1996, aquarium keeping is the second-most popular hobby after stamp collecting. In 1999, an estimated 9.6 million US households owned an aquarium. Figures from the 2005/2006 APPMA National Pet Owners Survey report that Americans own approximately 139 million freshwater fish and 9.6 million saltwater fish. Estimates of the numbers of fish kept in aquaria in Germany suggest at least 36 million. The hobby has the strongest following in Europe, Asia, and North America. In the United States, 40% of aquarists maintain two or more tanks.

In order to keep these conditions perfected for the fish, scientist needed to create machines. These devices used flames to heat up the water of the tank. In the 1900's, "After electricity was introduced into the home, fish enthusiasts began experimenting with electrical immersion heaters in glass tubes" (Paletta).

Until the 1920's fish keeping was only recreational. Slowly people started to breed captive fish like carp and started to sell them. The 20$^{th}$ century made a huge step in keeping fish. It was now possible for people to buy fish for their home aquariums instead of capturing them from the wild. At this time the common method of keeping fish consisted of glass framed tanks. Just like in earlier times, America no longer saw having a fish tank as luxury of the upper class.

The variety of fish grew immensely over time. Many wanted fish from all over the world, causing the importation of fish to become very popular. With other modern technologies like the plane, the importation of fish was made easier. The variety of fish available became tremendous. Fish were taken from areas such as the waters of Africa, Eastern Europe, and Asia.

This new variety of fish intrigued many hobbyists causing them to pursue new designs of fish tanks. By 1950 aquarists began to introduce marine, or ocean going fish, into aquariums. Most people who attempted to keep salt water fish in aquariums had to live close to the ocean to keep the tank water from becoming stagnant. Those who didn't live near the ocean had to resort to new equipment for their aquariums. "Understanding filtration systems, salinity needs, and live rock requirements all helped propel forward the saltwater tank for the home hobbyist." (History of Fish Keeping as a Hobby 1).

Another improvement of the hobby was the introduction of "fish food". Before the 1960's people had to prepare live and frozen fish food. This food consisted of brine shrimp, scallops, and mysid shrimp. Now people are able to feed their fish "flaked food" that comes prepared in a container. These small containers of prepared food could last months with out spoiling.

The fish keeping industry has grown greatly and people are able to readily buy and sell huge varieties of fish species. The availability of rare fish is so large that many governments are restricting and changing the laws regarding taking fish from the wild for domestication. Mastering the art of breeding rare fish has made it so we don't have to disturb wild populations. One of the main breeding facilities of fish in the United States is Oceans, Reefs, and Aquariums (ORA), which has a focus on breeding numerous species of clown fish.

The fish industry has also expanded into the hobby of keeping live corals and the fish species that can live harmoniously with them. During the 1980's and 1990's many fish companies started to take coral from reefs around the world and sell them to people with salt water aquariums. Today it is illegal to remove any corals from coral reefs in the wild. Aquarist must now rely on the propagation of aqua-cultured corals.

Indian Scenario

In India, the first aquarium was established in Madras. The plans for the Madras Aquarium were drawn up in 1905-1906 AD by Dr. Thurston, the then Superintendent of the Museum in consultation with a Committee. As this was the first Aquarium, methods of aeration, etc. found useful in Europe had to be suitably modified and adopted. The aquarium was opened to the public on October 21, 1909 AD and was very popular.

When the Fisheries Department came to be organised, the management of the aquarium was taken over by it on April 1, 1910 AD. During 1942 AD, owing to the threat of a Japanese attack on Madras, the city was evacuated, the collections in the Aquarium were thrown and it ceased to exist. Attempts to rebuild the aquarium have not fructified.

The popular Taraporewala Aquarium, situated in the city of Mumbai, India was built in 1951 at a cost of Rs 8,00,000, it hosts marine and freshwater fishes. The aquarium is located on the famous Marine Drive. The aquarium was named after a Parsee who donated Rs. 200,000 for the construction.

There were 100 species of marine and fresh water fish including seven types of coral fish from the Lakshadweep Islands. Attractions include sharks, turtles, rays, moray eels, sea turtles, small starfish and stingrays. Exhibits offered a glimpse of the variety of marine life in the Arabian Sea and Indian Ocean. There was also a room with fossils and preserved fish in bottles, along with rare sea shells.  Later public aquariums were established at Trivandrm and Banglore.

Present Status of trade:

The ornamental fish trade is a multi-million dollar industry and the global trade in ornamental fish is about US$ 6 billion and the entire industry including accessories and fish feed is estimated to be worth more than US$ 20 billion. About 7.2 million houses in the USA and 3.2 million in the European Union have an aquarium and the number is increasing day by day throughout the world. The fact is that USA, Europe and Japan are the largest markets for ornamental fish but more than 65 percent of the exports come from Asia. Tropical fresh water fishes contribute 80-90% of the world market, the rest being supported by tropical marine and fresh water species. In fresh water ornamental fish trade, 90 percent comes from aquaculture and remaining 10 percent from wild collections. Altogether 1600 species are involved in the trade. USA, Europe and Japan are the major markets and Singapore, Malaysia, Czech Republic, Spain, Indonesia, Japan, Israel, Thailand, Philippines and Sri Lanka are the major suppliers. FAO reported an annual 10 percent increase in ornamental fish trade globally, suggesting an overall increase in demand for ornamental fishes. The world market of ornamental fish trade is dominated by 30-35 fresh water species and major groups include guppy, neon tetra, angel, platy and gold fish. Out of the total fresh water trade, 60 percent of the share is contributed by Neon tetra and guppy.

Status of Asian countries:

More than 28 Asian countries are engaged in production and supply of ornamental fishes while, four countries, Singapore, Malaysia, Japan and Thailand shared more than 40 percent of global market. Other producers are Sri Lanka, Philippines, Indonesia, China, Taiwan, India and Vietnam.

Status of Indian trade:

Ornamental fish trade in India can be generally categorized into domestic trade and export trade. The domestic trade is dominated by exotic fishes like gold fish, angel, platy, guppy molly etc. whereas 95%  the export trade is contributed by the indigenous ornamental fishes of India.

An estimate carried out by Marine Products Export Development authority shows that there are one million fish hobbyists in India. The internal trade is estimated to be about Rs.15 crores and the export trade is in the vicinity of US$ 1.0 million. About 90 percent of Indian export goes from Kolkata 8 percent from Mumbai, followed by 2percent from Chennai. This is despite the country’s good tropical climate, varied freshwater resources, a long coastline and varied freshwater ornamental fishes. However, the growing demand for ornamental fishes and growing awareness for farming would change this scenario in India. At present India contributes only around 0.5 percent of world exports and this contribution have remained static mainly because India’s current export is almost exclusively based on wild caught fishes. This is not enough to cater to the demand.

| EXPORT FROM INDIA | | | | | | | |
|---|---|---|---|---|---|---|---|
| Country Name | | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 |
| JAPAN | Q: | 2 | 2 | 2 | 2 | 2 | 1 |
| | V: | 61.82 | 66.28 | 72.39 | 67.00 | 63.20 | 65.91 |
| | $: | 0.14 | 0.14 | 0.16 | 0.14 | 0.12 | 0.11 |
| USA | Q: | 3 | 2 | 4 | 4 | 3 | 2 |
| | V: | 57.19 | 52.18 | 52.38 | 54.84 | 49.88 | 47.44 |
| | $: | 0.13 | 0.11 | 0.12 | 0.12 | 0.09 | 0.08 |
| EUROPEAN UNION | Q: | 5 | 4 | 9 | 7 | 4 | 4 |
| | V: | 91.77 | 92.20 | 110.81 | 98.51 | 85.26 | 93.99 |
| | $: | 0.20 | 0.19 | 0.24 | 0.21 | 0.16 | 0.16 |
| CHINA | Q: | 4 | 10 | 29 | 1 | 6 | 3 |
| | V: | 32.49 | 62.37 | 96.18 | 31.27 | 43.01 | 37.23 |
| | $: | 0.07 | 0.13 | 0.21 | 0.07 | 0.08 | 0.06 |
| SOUTH EAST ASIA | Q: | 47 | 30 | 17 | 22 | 98 | 17 |
| | V: | 278.14 | 248.90 | 204.90 | 247.26 | 227.88 | 285.99 |
| | $: | 0.64 | 0.52 | 0.45 | 0.53 | 0.42 | 0.48 |
| MIDDLE EAST | Q: | 6 | 7 | 7 | 16 | 11 | 5 |
| | V: | 15.97 | 21.28 | 16.53 | 33.09 | 26.39 | 20.47 |
| | $: | 0.04 | 0.05 | 0.04 | 0.07 | 0.05 | 0.04 |
| OTHERS | Q: | 2 | 2 | 3 | 3 | 2 | 1 |
| | V: | 5.87 | 10.72 | 16.71 | 15.76 | 12.20 | 16.96 |
| | $: | 0.01 | 0.02 | 0.04 | 0.03 | 0.02 | 0.03 |
| Grand Total | Q: | 69 | 56 | 70 | 54 | 126 | 34 |
| | V: | 543.26 | 553.93 | 569.90 | 547.72 | 507.81 | 567.98 |
| | $: | 1.23 | 1.17 | 1.26 | 1.16 | 0.94 | 0.95 |

Present status of ornamental fish in India

There is considerable development regarding the hobby of aquarium keeping and ornamental fish farming in India especially in Kerala during the last decade due to various research, training and extension initiatives carried out by Government and Universities. They are

1. Research on the indigenous ornamental fishes of the Western Ghats of India under the ICAR-NATP-project carried out at College of Fisheries, Panangad, Cochin under Kerala Agricultural University. As a result a data base of the ornamental fishes of the Western Ghats of India has been prepared. Captive breeding technology for 14 prioritized species of fishes have been developed which is the first of its kind in India.
2. Developed and standardized captive breeding technology for the most sought after indigenous ornamental fish –*Sahyadria denisonii*- funded by MPEDA
3. Extension activities conducted exclusively for Kumbalam Panchayath where 300 families were trained. Most of them have adopted ornamental fish culture as a livelihood in the village.

4. Various schemes of Government agencies like Matsyafed, FIRMA, NFDB, MPEDA, KAVIL for the promotion of ornamental fish culture and trade.
5. International AQUASHOW and seminar being conducted at Cochin every alternate year for the promotion and popularization of ornamental fishes.
6. Guidelines for the green certification of ornamental fishes were prepared which is the first of its kind in the world.

   In spite of all these, the farming and trade has not been flourished in proportion to its potential of India. The main challenges which are to be addressed immediately are:

1. As in the case of food fish, ornamental fish sector is not organized and there is no single institution to take care of the different challenges the sector is facing.
2. The export market is mainly based on wild caught fishes. This cannot assure supply of the increasing demand.
3. Mechanism to implement quality assurance and animal welfare conditions.
4. Mechanism to import quality brood stock of prime species of exotic fishes to cater to the demand of domestic market.
5. Strengthening of research and development for the development of captive breeding technology, live feed culture, quarantine and biosecurity issues.
6. Skilled manpower to cater to various positions of aquarium curators, hatchery operators and trainers training.

Scope of domestic Ornamental fish Market in the next Quarter Century.

According to Lukram (2005) the domestic market worth around Rs.500 million and the demand is increasing at 20% annually.

This can be discussed under the following heads

- Hobby
- Research & Education
- Employment
- Trade

1. Hobby:
2. The hobby of ornamental fish keeping in Metro India will outgrow many of the developed countries by next decade (Jain and Mercy 2015).
3. The hobby of aquarium keeping is growing in country for several reasons.
   - increasing per capita income
   - increasing number of middle income group population
   - the increasing number of nuclear families specifically in metro India.
4. The faith of an average Indian on the concepts of Vastu, Fengshui and other religious factors.
5. Developmental institutes have introduced many innovative schemes
   - funding support to set up ornamental fish breeding unit
   - setting up of public aquarium gallery
   - installation of aquarium in schools and colleges
   - development of skilled manpower in the field of “Ornamental Fisheries”.
6. The ongoing effort of local administration and tourists departments in few Indian states to develop public aquarium gallery

Strength: Aquarium keeping as a hobby will definitely increase in the near future. About 50% of the populations all over the world are living in urban areas and hence the outfield hobbies are restricted. India, with the huge population of 125 crores of people, is a big market for this hobby. In this scenario, the domestic market can be developed much better than the overseas market.

Opportunity: There are opportunities for procuring these skills either from abroad or from India itself. These have to be exploited. Now advance technology is available for all aspects of aquarium keeping. We have to make use of it.

- Research:

  Strengths: As early mentioned, India is blessed with a rich diversity of indigenous and endemic fresh water ornamental fishes both in the Western Ghats and North eastern Hills. Similarly India, bestowed with a long coastline and many island groups in Indian Ocean, also has lot of marine ornamental fishes. There is tremendous scope for research in this field.

  Opportunities: Aquarium fish keeping is a hobby craving for novelty every time. Since we have a diversity of germplasm it can bring out lot of demand in the trade both at the domestic and export market. There is great opportunity for strengthening R&D in this field.

- Employment:

  Strengths: Manpower is the greatest strength of our country. Educated, qualified, enthusiastic and energetic people are abundantly available in the country. If they can be selected, motivated, trained and guided properly, there is abundant scope for employment.

  Opportunities: Demand for ornamental fishes in domestic and export market is huge. If the fish and other products can be produced in a sustainable way, there is lot of opportunity for trade.

- Trade:

  Strengths: Aquarium keeping is a hobby that sustains on novelty at an affordable rate other than any other criteria. India is blessed with a rich biodiversity that can cater to the needs of this hobby. There is sustainable demand for ornamental fishes of India.

  Opportunities: Both in domestic and export market, there is great demand. There are opportunities for producing new varieties, bring novelty, and thus exploitation of market. R &D has to be strengthened.

Strategies for the better future of ornamental fish culture development.

1. Mass production and supply of high quality fishes for meeting the demand of local and export markets
2. Standardize the captive breeding technology for more species of indigenous marine and fresh water fishes
3. Exploit the potential of water resources, germplasm, ideal climate conditions, and educated manpower for the mass production of ornamental fishes.
4. Bring all the farmers and entrepreneurs under the purview of a single institution to generate maximum production, income and employment.
5. Implement green certification guidelines so as to assure quality, biosecurity and farm accreditation.

6. Strengthening of the institutional support by intensification of research and development, training programmes and extension activities etc.
7. Strengthening of R&D of biotechnological applications for the development of new strains.

Conclusion.

- Ornamental fish culture and trade is an additional source of income and a livelihood option.
- Breeding of native and exotic fishes and production of other equipments will provide good employment opportunities and substantial income.
- Since this is a capital light and technology light industry it can be easily adopted by poor farmers, women and unemployed youths.
- It is essential to shift the focus from capture to culture based development for assured and adequate supply of demand that leads to the sustainability of growth.
- India has great potential to become a major player in global ornamental fish trade in the coming years.
- Specialized courses on Aquarium science has to be conducted to cater to the need based profession in the field.
- It is essential to have a centralized single organisation/agency to monitor/regulate the research, Trade and employment opportunities.

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# Chapter 19

## Prospects of micro-financing in fisheries sector

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*"People were poor not because they were stupid or lazy. They worked all day long, doing complex physical tasks. They were poor because the financial institution in the country did not help them widen their economic base."*
***— Muhammad Yunus***

Poverty of its rural population is the major challenge to any developing society and eradication of poverty has remained as the most complicated and serious concern world over, especially in developing countries. Poverty is a cumulative effect of many predicaments such as lack of asset, under employment, uncertain and relatively unproductive employment, low remuneration, economic vulnerability, illiteracy, social disadvantage etc.

The rural areas were found to be more prone to poverty, even if it exists in urban areas also. The rural poor are perpetuating poverty and are the victims of the "vicious cycle of poverty". Fishing communities in the coastal belts all over the world are also not an exception to this. Poverty in fishing communities is very common and is characterized by high population density, poor living conditions, lack of proper education and poor access to education and health care. Due to poor attention paid by the state, the infrastructure support like roads, electricity, good drinking water, markets etc also are dismal for poor.

Though efforts for reducing fishing pressure is taken by Government, scope for alternative employment opportunities are less. Most of the time, artisanal fishers, who are engaged inthe world's most dangerous occupations, are positioned on par with landless agricultural labourers and marginal farmers as far as India is concerned. The loss of a fishing equipment or an active fisherman in the family can be tragic and lead to total financial deprivation of the family. Hence poverty and vulnerability in fishing communities is widely known but poorly addressed. As a result, in rural farming sector, dependence of fishing communities on private moneylenders continues in many areas, especially for meeting emergent requirements. For various reasons, credit to these sections of the population has not been institutionalized. But for implementing any successful fishery management programme, this issue is to be addressed first.

The emergence of microfinance as an alternative financial delivery mechanism was a response to the failure of past efforts by the state to provide financial services to the poor. But while considering micro finance programmes for fisheries sector, there should be special considerations that are unique to fishing communities and need special consideration. Instead of random payment of loans to target sectors and populations, efforts are to be taken for setting up and building local institutions that cater to the poor. Efforts in this direction resulted in the formation of microfinance institutions (MFIs) that serve the rural poor. MFIs initially started providing microcredit but have now extended their services to savings, insurance etc. Fact proved by successful MFIs is that the poor surely have the capacity to repay loans, pay the real cost of loans and generate savings.

**What is Micro Financing?**

Micro finance refers to a category of financial services, including loans, savings and insurance, to benefit poor entrepreneurs and small business owners who have no collateral and wouldn't otherwise qualify for a standard bank loan or lack access to the mainstream finances.

**Micro Finance Institution**, also known as MFI, a microfinance institution is an organization that offers financial services to low income populations. Almost all give loans to their members, and many offer insurance, deposit and other services.

**Microcredit** is the extension of very small loans (microloans) to impoverished borrowers who typically lack collateral, steady employment and a verifiable credit history

In Indian context, Microfinance Institutions Network (MFIN) is an association for the microfinance sector. Its member organizations constitute the leading microfinance institutions in the country. MFIN is a primary representative body and the Self-Regulatory Organization (SRO) for Non Banking Finance Companies (NBFC)

The mechanics of a microfinance operation basically involve three levels:

i) the borrowers who take out loans that they invest in micro businesses;
ii) the loan delivery and recovery system; and
iii) the institution or organization that manages the delivery system.

The successful operation of these levels is premised on the twin principles of client discipline, where borrowers take responsibility for their decisions and agreements made with the MFI; and institutional discipline where MFIs offer and provide products and services characterized by quality, efficiency and commitment.

These are individual and group-based approaches. Individual lending is credit provision to individuals who are not members of a group that is jointly responsible for loan repayment. As it is documented and asset-based, lending is provided to individuals based on their ability to give the MFI assurances of repayment and some form of collateral, or a willing co-signer.

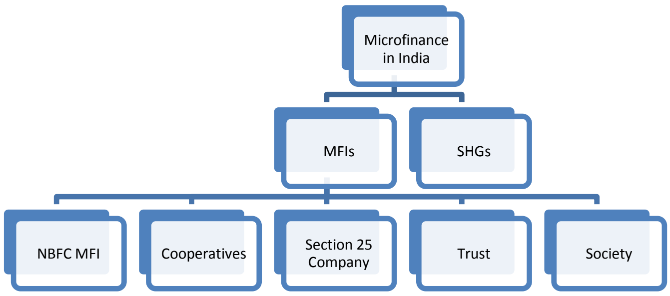
Group-based lending may have a more practical applicability for small-scale fishers and fish farmers. This involves lending to groups of people, either to individuals who are members of a group who guarantee each other’s loans, or to groups that sub loan to their members. Self-help groups (SHGs) are prominent in this model.

**Micro banking –Indian context**

Microfinance Institutions (MFIs) are regulated by the Reserve Bank of India (RBI). MFIN currently has a membership of 42 NBFC MFIs, which on an aggregate basis constitute over 89% of the microfinance business in India.

The major types of microfinance involving credit linkages with banks in India are (i) SHG - Bank Linkage Model: This model involves the SHGs financed directly by the banks viz., CBs (Public Sector and Private Sector), RRBs and Cooperative Banks. (ii) MFI - Bank Linkage Model: This model covers financing of Micro Finance Institutions (MFIs) by banking agencies for on-lending to SHGs and other small borrowers.

**Figure 1: Microfinance Situation in India**




MFIs currently operate in 29 States, 4 Union Territories and 588 districts in India. The reported 166 MFIs with a branch network of 12,221 employees have reached out to an all time high of 39 million clients with an outstanding loan portfolio of Rs 63,853 crore. Of the total, NBFC-MFIs contribute to 85% of clients outreach and 88% of outstanding portfolio, while NGO MFIs contribute to the remaining. MFIs with portfolio size of more than Rs 500 crore contribute significantly to the total outreach (85%) and loan outstanding (88%) of the sector.

In the last one and half decades, Self Help Groups have emerged as a new paradigm for combating poverty and rural unemployment in India. ‘Grameen Bank of Bangladesh, the brain child of Prof. Mohammed Yunus, can be referred to be the precursor of Self Help Groups or micro credit groups or lending groups. Self Help Group (SHG) mode of Savings and Credit was reported to be very efficient by NABARD and ILO due to their potential to bring together the formal banking structure and the rural poor for mutual benefit and that their working has been encouraging. Now it has become a country wide movement, followed by the NABARD sponsored SHG-Bank linkage programme, which started in 1992.Pathak (1992) observed that the SHG, being comprised of group of persons, gets empowered to solve most of their problems like, raw materials and input supply, marketing, better adoption of technology, education and training for realizing the human potential for development. Since the SHG movement is now a country wide programme, it is essential to assess the impact of SHGs in terms of empowerment, especially in view of the dearth of such studies. Same was reported to be true in the case of fisheries sector by Vipinkumar.V.P* & Swathi Lekshmi.P.S (2012)

Coming to Indian fisheries, constituting about 6.3% of the global fish production, the sector contributes to 1.1% of the GDP and 5.15% of the agricultural GDP. The total fish production of 10.07 million metric tonnes presently has nearly 65% contribution from the inland sector and nearly the same from culture fisheries. But the coastal fishing villages in India are thickly populated as fishermen prefer to stay along the coast line owing to access to sea. As in other part of the world, especially in the developing countries, poverty and vulnerability are the typical features portraying the traditional fishing communities.

The scope of extending micro finance to fishing communities is already explored in India and has found fruitful in the past few years. The scattered attempts are to be further extended and scaled up at national level, for which efforts are on the way.

**Who are providing micro finance?**

Microfinance providers can be classified as formal financial institutions, semiformal institutions and informal providers. Formal financial institutions are subject to banking regulation and supervision and include public and private development banks and commercial banks, among others. Semiformal financial institutions, notably NGOs, credit unions and cooperatives and some SHGs, are not regulated by banking authorities but are usually licensed and registered entities and are thus supervised by other government agencies. Informal providers are those entities that operate outside the structure of government regulation and supervision.

Experience shows that governments are inefficient microfinance providers and therefore should not lend funds directly to poor borrowers. Government-implemented microfinance programmes that are usually subsidized and operated through state-run financial institutions are unsustainable, as they are often perceived as social welfare

While the majority consider Micro-finance as a savvier of the rural poverty, there is increasing criticism on the concept of Micro Finance (which was conceived and propagated by Muhammad Yunus - Founder of Grameen Bank and Nobel Peace Prize recipient) as it is a well-meaning intervention which has not worked out as was intended as it enables only the Micro-credit providers, not the poor (Bateman, M 2014). Hence, while attempting to provide micro finance in fisheries sector, those services could include the following:

**Principles of financially viable lending to poor entrepreneurs**

**Principle 1. Offer services that fit the preferences of poor entrepreneurs**

- Short-term loans, compatible with enterprise outlay and income patterns
- Repeat loans - full repayment of one loan brings access to another. Repeat lending allows credit to support financial management as a process rather than as an isolated event
- Relatively unrestricted uses - while most programmes select customers with active enterprises, they recognize that clients may need to use funds for a mixture of household or enterprise purposes
- Very small loans, appropriate for meeting day-to-day business financial requirements
- A customer-friendly approach - locate outlets close to entrepreneurs, use simple applications and limit the time between application and disbursement to a few days
- Develop a public image of being approachable by poor people

**Principle 2. Streamline operations to reduce unit costs**

- Develop highly streamlined operations, minimizing staff time per loan
- Standardize the lending process
- Make applications very simple and approve on the basis of easily verifiable criteria, such as the existence of a going enterprise
- Decentralize loan approval

- Maintain inexpensive offices
- Select staff from local communities

**Principle 3. Motivate clients to repay loans**

Substitute for pre-loan project analysis and formal collateral by assuming that clients will be able to repay. Concentrate on providing motivation to repay such as:

- *Joint liability groups.* An arrangement whereby a handful of borrowers guarantee each other's loans is by far the most frequently used repayment motivation. Individual character lending can be effective when the social structure is cohesive
- *Incentives.* Guaranteeing access to loans motivates repayments, as do increases in loan sizes and preferential pricing in exchange for prompt repayment. Institutions that successfully motivate repayments develop staff competence and a public image signalling that they are serious about loan collection

**Principle 4. Charge full-cost interest rates and fees**

The small loan sizes necessary to serve the poor may result in costs per loan requiring interest rates that are significantly higher than commercial bank rates (although significantly lower than informal sector rates) *(Source:* Rhyne and Holt, as cited by Ledgerwood, 1999.)

Some more points to take into account inthe case of Fisheries are given below:

- As seasons play a critical role in the success of capture fisheries and fish farming, the availability of credit should be assured in time. Also, as capture as well as culture fisheries are occupations requiring fairly good level of skill, required training and technical guidance are crucial for the success of their endeavours. The organisations involved must take a note of these points also to enable the fisherman succeed in his venture and repay the loan in time.
- A thorough understanding of the socio-cultural context in fishing communities is made more critical in microfinance because it requires strong social bonds among the borrower groups to enforce discipline to repay loans.
- Analysis of different socio-economic subgroups in fishing communities, to identify the subgroups most in need of financial services to support their enterprises
- It is highly relevant to study important demographic and socio-economic changes have taken place in recent years in coastal fishing communities
- As income is not regular or uniform from both capture and culture fisheries, an estimation of the market size for microenterprises and their products must be made to ensure that enough demand for financial services exists, thereby ensuring the long-term sustainability of microfinance operations.
- Preference should be for those who already have identified or existing microenterprises but who need financial services, either to expand or build up their asset base, compared to those planning to start from scratch
- Globally, women constitute the majority of microfinance clients, primarily because of their better repayment records. Women play an important role in fishing communities, encompassing social and economic responsibilities and duties. Generally, loan size requirements are small for women, which makes them appropriate clients of microfinance.

- Global experience has demonstrated that subsidized interest rates are not financially sustainable. Therefore, a balance between a market-based interest rate regime that allows the MFIs to cover all their costs on the one hand and what the clients can afford and what the market will bear, on the other, must be reached
- Successful group-based lending usually starts with small loans, gradually increasing based on repayment history. The guiding criteria for both fishery and non-fishery based projects should be the viability and profitability of the chosen economic activities.
- For most MFIs, repayments are made on an instalment basis (weekly, biweekly, monthly) for activities that generate ongoing revenues. In fishing communities, this would be appropriate for fish marketing and trading projects. For seasonal activities, such as in aquaculture and fish farming, where expected revenues are realized at harvest time, lump sum payments would be appropriate.
- There are two kinds of savings services provided by MFIs: compulsory and voluntary savings. Compulsory savings are funds contributed by borrowers as a condition for receiving a loan. Voluntary savings operate on the principle that the poor already save and only require appropriate institutions and services to meet their needs. (Uwe Tietze and Lolita v. Villareal 2003).

**Conclusion**

All those who are interested in alleviating the rural poverty, especially that in the coastal fishing villages of India , where the human development indices are often on par with tribal villages, through micro-finance concept, either through governmental or nongovernmental agencies, should make sure that the effort is being made after thorough study of the area including the demographic details, history of cultural and social evolution in that area, the behavioural patterns of intended beneficiaries, their probable occupations, market potential etc. Unless it is not a well planned and integrated effort adding inputs like technology, skill, market, management etc along with finance, there is no guaranty that the mission turn out to be a success.

“This is not charity. This is business: business with a social objective, which is to help people get out of poverty.” Muhammad Yunus - Founder of Grameen Bank and Nobel Peace Prize recipient

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# Chapter 20

## Data and computational needs in fisheries research and management

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### INTRODUCTION

Statistics is extensively employed in many real-world measuring processes. It has wide applications in any branch of science or research viz., agriculture, meteorology, oceanography, forestry, fisheries, animal husbandry, geology, epidemiology, medicine, communication, visualization, education, politics, psychology, atomic physics, space research, climate change studies, economics and governance. Statistics also gets applied in many unconventional fields like mining and law. . A method called "kriging" enables scientists to interpolate a smooth distribution of some quantity of interest from sparse measurements. This method actually evolved out of data from gold mines when in 1950, a South-African mining engineer named DanieKrige used statistical techniques and assumptions to locate optimum places where boreholes can be drilled to extract gold ores.Genomics is another such field where the discovery through statistical methods of "biomarkers"—genes that confer an increased or decreased risk of certain kinds of cancer

Contribution of fisheries sector to GDP 1.1% and 5.0% to the agricultural GDP.Fisheries is one of the largest employer in the rural sector, providing direct and indirect employment to millions of rural poor, especially the weaker sections of the society. Fisheries sector also undergoes continuouschanges with introduction of newer technologies evolved through R& D institutions. Validation of these technologies and providing inputs for needs of the sector is one of the important mandate of Statisticians. Statistics per se deals with generation of data, data management, data analysis and information generation from data.

Statistics and the advanced methods are key to fisheries research and management. Fisheries with its varied disciplines viz., Aquaculture, Fisheries Resource Management, Fish Genetics, Fish Biotechnology, Aquatic Health, Nutrition, Environment, Fish Physiology and Post-Harvest Technology is a vibrant field with research taking place in practical aspects which affect production and sustainability. Statistics can play a crucial role in formulating advisories and policies for stakeholders at all levels.

Statistical system can play more dominant role

- in providing tools for policy making and implementation
- in directing the impact of technology
- in sustaining the nutritional safety
- in socio-economic upliftment of people below poverty line
- to identify emerging opportunities through effective coordination
- speedy dissemination of information by networking and appropriate human resource development

**DATA NEEDS IN FISHERIES**

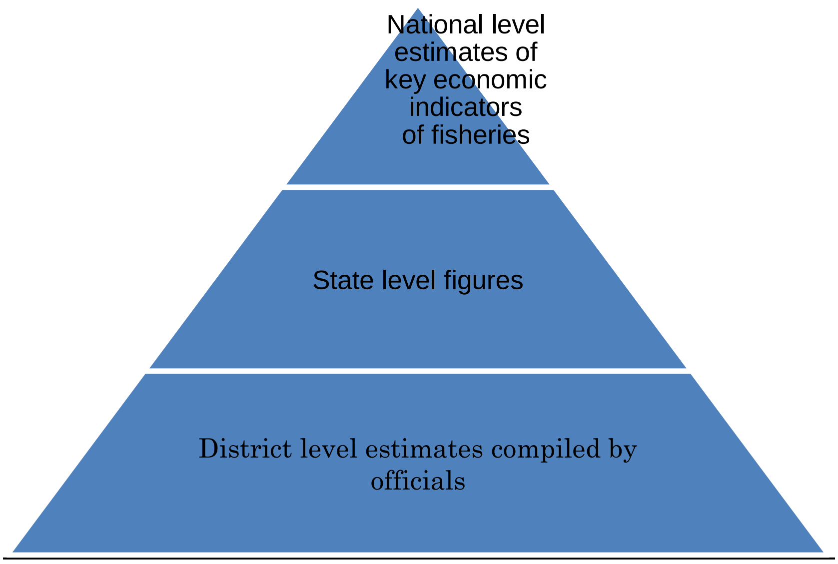
The data needs in fisheries will vary according to type of research conducted by the researcher. A biologist who works on species behavior, growth, abundance, etc.will require information on the spatial distribution and catch. Likewise, an economist who wishes to predict next year's profits should understand the effect of population size on producer's costs. Policy makers may need macro level data on infrastructure, employment, earnings, investment etc. to formulate management measures.

Data on marine fisheries gets generated from the operation of commercial fishing vessels and research vessels.In 'Fishery technology' large volumes of data generated in a wide range of applied scientific areas of fishing technology, fish processing, quality control, fishery economics, marketing and management. Apart from statistical data collected in technological research, data also collected on production, export, socio-economics etc. for administrative and management decision making.

Major areas of data generation:

- fishing vessel and gear designs
- fishing methods
- craft and gear materials
- craft and gear preservation methods
- fishing efficiency studies
- fishing accessories
- emerging areas include use of GIS and remote sensing

Data on various aspects of fishing gets collected for administrative purposes and policy making. For administrative purposes, voluminous data gets generated through fisheries departments of states. Each district has officials entrusted with the work of collection of data which are coordinated at the state level. State level figures are compiled at the National level by Department of Animal Husbandry and Dairying, Ministry of Agriculture, New Delhi.



Information is also compiled on macro economic variables like GSDP from fishing by the respective Directorates of Economics & Statistics.

Infrastructure

Indian fisheries is supported by a vast fishing fleet of 2,03,202 fishing crafts categorized into mechanized, motorized and non-motorised. The registration of these fishing crafts are done at various ports across India and license for fishing operations has to be obtained from the respective states. The fish processing sector largely managed by the private sector has per day processing capacity installed at 11000 tonnes per day. Data is also collected on the infrastructure facilities and inventories by agencies from time to timesuch as number of mechanized, motorized and non-motorized fishing crafts, fish landing centers, fisheries harbours, types of gears and accessories, fish markets, ice plants and cold storages, Socio-economic data like population of fishermen, welfare schemes, cooperative societies, financial assistance, subsidies, training programs, etc.

Fish Landings and fishing effort

Indian fisheries has seen tremendous development over the past six decades owing to technology changes in fishing like mechanization of propulsion, gear and handling, introduction of synthetic gear materials, development of acoustic fish finding devices, satellite based fish detection techniques, advances in electronic navigation and communication equipment. The increase in fish production can be said as exponential with a mere 75000 MT in 1950-51 to 11.42 million MT in the current year. Both marine fisheries and aquaculture have contributed to the present level of production with share from culture fisheries more than the capture fisheries. It is important task to collect macro level data from state and country on fish production and details of the species caught in the sea.

The data on fish catch and effort (a measure of fishing activity of vessels at sea), from all the coastal states, Union territories, Islands is being done by ICAR-Central Marine Fisheries Research institute and maintained as database. Based on standard sampling methodology developed by CMFRI, daily data on commercial landings from selected centres/zones all over the coast is collected, compiled and published.Detailed time series data has been generated on species wise, region wise, gear wise fish landings are collected and compiled for the use of researchers and policy makers. The beach price of fish (species wise) is also collected periodically.

Data on fish farms, production and area under aquaculture is maintained by the respective State Fisheries departments and compiled at the National level. Apart from capture fisheries (marine) and culture fisheries (aquaculture) the fish production from inland water bodies like lake, ponds, reservoirs, etc. is collected and compiled at State level. For developing the sector, various programmes and projects have to be formulated and implemented. To achieve the objectives of such developmental programmes, the current status of production of fish from various regions has to be made known. The need for fish production data maintained by these agencies from marine sources, aquaculture and inland water bodies arises while formulating various research studies and development projects at district, state and National level.

Data generation along the fish value chain

Fresh fish after harvest is iced and distributed through various channels into the domestic markets and overseas markets. Around 80% of the fish is marketed fresh, 12% of fish gets processed for the export sector, 5% is sent for drying/curing and the rest is utilized for other purposes.

Marine Products Export Development Authority (MPEDA) maintains the database on export of fish and fishery products from India to various country. The weekly prices realized by Indian seafood products in the various overseas markets are also collected and compiled by the agency.Marine Products Export Development Authority (MPEDA) established in 1972 under the Ministry of Commerce responsible for collecting data regarding production and exports, apart from formulating and implementing export promotion strategies. Prior to the establishment of MPEDA, Export Promotion Council of India was undertaking this task.

Fish processing factories established all over the country generate data on daily production, procurement of raw material and movement of price structure etc. which is generally kept confidential.Data on quality aspects maintained by Export Inspection Council of India through Export Inspection Agency (EIA) in each region, under Ministry of Commerce and Industry. The EIA is the agency approving the suitability of the products for export.

- bacteriological organisms present in the products
- rejections in terms of quantity
- reason for rejection etc.

Fish quality control

Other types of data generated by CIFT in fishing and fish processing technology are quality control data on fish and fishery products, ice, water, etc. Offshoot of processing technology is Quality Control of which Statistical Quality Control forms an integral part. Due to the stringent quality control measures imposed by importing countries, especially the EU and USFDA standards samples of fish and related productslike raw materials, ice and water samples and swabs from fish processing factories are tested at the quality control labs. Another area where statistics gets generated is in product development : consumer acceptability and preference studies mainly for value-added products. Using statistical sensory evaluation methods this data gets analysed.

At Central Institute of Fisheries Technology (CIFT) we are periodically collecting data on the following aspects which is used for policy decisions

- Techno-economic data on various technologies developed
- Data on Economics of operation of mechanized, motorized and traditional crafts
- Data for the estimation of fuel utilization by the fishing industry
- Year wise data on Installed capacity utilization in the Indian seafood processing industry
- Demand – supply and forecast studies on the fishing webs
- Harvest and post-harvest losses in fisheries
- Transportation of fresh fish and utilization of trash fish
- Impact of major trade policies like impact of anti-dumping, trend analysis of price movement of marine products in the export markets
- Study on impact of technology and study on socio-economic aspects

**Weaknesses of the fisheries statistical system**

The major weakness of the fisheries statistical system is the lack of effective coordination between Central and state agencies in collecting data. Many a time, the credibility of data is in question as no common methodology and format is being adopted. There exists no coordinating centre to scrutinize quality and authenticity of data collected and for providing common statistical approach for various issues. Alsomany data gaps exists at the micro level, like lack of data on private capital investment and price movement in domestic as well overseas market. The data provided by many agencies are not updated over time and lack of interaction among officials and data exchange that is vital to the functioning of a dynamic system. There is no prioritization of the data requirement is attempted and non availability of trained manpower is observed to be a major problem in this area. A common data bank comprising of all major fisheries statistics must be evolved which should be accessible to all stakeholders, including government departments.

Future of Indian fisheries & role of statistics

In the background of WTO and other economic reforms, the fisheries technology will play a significant role in the economic development of the country. India is attempting to emerge as one of the top fish producing countries in the world. With a fish production projected at 13 million MT and getting equipped for export of marine products to a tune of 18.9 lakh metric tonnes,the sector is set to provide employment to about 20 million people. Fisheries sector is poised to make a significant impact on the economy of the nation particularly on the socio-economic conditions of the rural population.

In order to make Indian seafood exports competitive, effective strategies have to be developed. New areas of technological research are emerging to increase production and sustain the sector. Modern marketing strategies including market intelligence will play a key role in the future and techno-economic studies will become imperative. Large volume of statistical data expected to be generated in the scientific areas, fishing and fish processing industry, export market and fishery management.

Ensuring quality of data and management of data for generation of valuable information not going to be easy.Complete restructuring of fisheries statistical system in this background with common accessible database and a central coordinating agency for fisheries to monitor, guide and improve the existing system is the need of the hour.

Computational software

From data punching using cards, computation has come a long way over the past century. With the advent of personal computers, data management and analysis had become a lotmoreeasier. Prior to the development and use of statistical software data analysis was done using programming in languages like FORTRAN. A plethora of computing software is available for analysis of data suitable to the needs of researchers.

(i) Statistical Package for the Social Science. SPSS is one of the most popular statistical packages which can perform highly complex data manipulation and analysis with simple instructions and is widely used by researchers. The GUI software has data management features, wide range of analytical options, plotting and missing data options.

(ii) The FishStatJ application developed and maintained by FAO provides users yearly timeseries data on variety of aspects of fisheries. Data on global capture fisheries and aquaculture fish production can be obtained from this application.

(iii) FiSAT is a program package containing methodologies for fish stock assessment and was developed by FAO-ICLARM. The ASSESS module of the package handles the growth parameter estimation, analysis of length frequency data, virtual population analysis and stock prediction.

(iv) The LFDA (Length Frequency Data Analysis) software package is useful for estimation of growth parameters and mortality. The Catch Effort Data Analysis package (CEDA) is a PC-based software package for analysing catch, effort and abundance index data.

(v) Plymouth Routines in Multivariate Ecological Research (PRIMER) is used for statistical analysis of multivariate data including species assemblages, physico-chemical variables, genetic, microbial data. Assessment of environmental impact of oilfields, discharges, mining, trawling, aquaculture can be done using the software. Another unique feature of PRIMER is the ability to calculate bio-diversity indices based on taxonomic distinctness or relatedness of the species.

(vi) Data Envelopment Analysis Models are used for examining technical and economic efficiency of fishing fleets. DEAFrontier uses Excel Solver as the engine for solving the DEA models. In order to run the DEAFrontier software, Excel Solver must be installed in the Excel.

(vii) SAS (Statistical Analysis Systems) is a versatilesoftware aiding in advanced analytics, multivariate analyses, business intelligence, data management, and predictive analytics. The programming environment helps in customized analysis of data. The procedures which are components available in the software allows the user to perform analysis and data management as well as produce text-based and graph-based output.

(viii) R is a programming language and free software environment for statistical computing and graphics. The dplyr and ggplot2 packages for data manipulation and plotting are excellent features of the software. R is the best way to create reproducible, high-quality analysis and graphs. It has all the flexibility and power as it is a vector based language.It is freely downloadable from the CRAN (Comprehensive R Archive Network - The website which keeps the R job) repository.

(ix) PAST (PAleontologicalSTatistics Software) is free software for scientific data analysis, with functions for data manipulation, plotting, univariate and multivariate statistics, ecological analysis, time series and spatial analysis, morphometrics and stratigraphy.

# Chapter 21

## Forecasting using Delphi method: an Overview

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The Delphi is a structured communication technique. It involves iterative process of data collection and analysis until consensus is reached among anonymous experts in relation to complex situation. The method is named after Greek oracle at Delphi who was said to be consulted about important decisions by Greek citizen especially in relation to uncertain future.

Evolution of the method dates back to cold war era. The method was developed by Norman Dalkey of the RAND corporation in the 1950's for a U.S. sponsored military project. It was presented in the public domain in 1964. T,J.Gordon and O.Helmer used Delphi method to assess the future development in six broad specific areas and submitted the findings titled "Report on a Long-range Forecasting Study", (Dephi Survey tutorial,T&l,2030)

The method has got variety of applications, from decision-supportandforecasting (Rowe and Wright, 1999) to program development and administration (Delbecq et al., 1975). The method is preferred in situations where knowledge about a problem or phenomena is incomplete or not available. (Adler and Ziglio, 1996; Delbeq et al., 1975). The method is especially applicable to the context where subjective perceptions based on experience and expertise are preferred rather than interpreting the available information by subjecting it to the analytical techniques.(Adler and Ziglio, 1996). It tries to capitalise on the potential of collectivewisdom for problem solving and forecasting (Linstone and Turloff, 1975).

The method was used by many researchers for seeking consensus on complex phenomena in addition to its utility in expert elicitation and forecasting. With the increasing popularity and use, functional classification has emerged overtime like policy Delphi, advisory Delphi, decision Delphi etc. (Lang, 1998).

Rowe and Wright (1999) characterized the classical Delphi method with four key features:

1. Anonymity of the respondents: The respondents are not informed about the details of other respondents. The intention is to facilitate free low of opinion and responses, without any biases and undue pressure to agree with the response of a dominant participant.

2. Controlled feedback: The collective perspective or summary of the responses of the participants is provided to the respondents after the collection and analysis of their response to help them to revisit their perspective.

2. Iteration: The techniques allow number of rounds of information collection and feedback. It helps the respondents to refine their responses considering the overall

feedback in the previous round. It should be taken care that respondents are simply agreeing to the majority's opinion in the previous round. Rather it should be based on their expertise.

4. Statistical analysis of group response: The method has provisions for a quantitative analysis and interpretation of responses which are qualitative in nature.

Rowe and Wright (1999) suggested that only those studies which are true to their origins and that have the four characteristics should be classified as Delphi studies, while others (Adler and Ziglio, 1996; Delbeq et al., 1975; Linstone and Turloff, 1975) advocated that the technique can be effectively modified to meet the needs of the given study.

**Delphi procedure**

The Delphi exercise involves number of steps to elicit the response of group of experts or members of intended audience andfurther to modify it. (Rothwell and Kazanas, 1997). The process starts with selection of experts. It is followed by development of questionnaire which can be structured (Rothwell and Kazanas, 1997), and comprehensive of the area of study or unstructured which mainly involves the open ended questions related to area of investigation (Lang, 1998). The questionnaire issent to the respondents through online or offline modes. The responses collected are analysed and used develop questionnaire for next round. The procedure is repeated until there is consensus.

The information generated is processed and used by the investigating team to develop a subsequent more focused questionnaire, which is distributed together with the results of the previous round to participants in the third step of the procedure. This process of synthesizing data and refining the questionnaire continues until there is agreement of opinion among participants (Lang, 1998).

Delbecq et al., (1975) described the Delphi technique with the following steps:

1. Formulation questionnaires: The questionnaire may be open ended or require response on a rating scale. They are revised for each round based on the responses from previous round

2. Selection of experts: Experts are selected using snow ball technique, where key informants identify and recommend the experts in the particular area.

3. Sample size: The sample usually varies between 10-30. Anecdotal evidence points out that a sample between ten to twenty is sufficient.

4. Distribute the questionnaire:Sent the questionnaires to selected respondents and collect the responses in prescribed time.

5. Data analysis.: Collected responses are analysed using appropriate statistical techniques to see whether sufficient degree of consensus exist among respondents.

6. Formulation of questionnaire for second round, distribution and collection of feedback: The questionnaire for second round has to be developed based on the feedback from first round. The respondents should be requested to review their responses in this round

7. Data analysis: The responses from send round also analysed for possibility of consensus among experts. If sufficient consensus is reached, the iteration can be stopped. Otherwise the process will continue to next round.

8. Formulation of questionnaire for third round, distribution and collection of responses:Provide the summary of second round to respondents and ask them to review their responses in light of the collective feedback. The collect the responses

9. Data analysis:Consensus is examined using different measures.

10. Develop the conclusion and prepare final report.

**Measuring Degree of Consensus**

It was observed that, most of the researchers used quantitative and statistical measures such as mean, median, mode, standard deviation, skewness index, interquartile range, and rank for assessing the degree of consensus (Trexler et al., 2006). Some researchers have opined that criteria of consensus need to be identified based on the topic of the research (Kantz, 2005). The method is lacking a universally accepted measure of consensus. It is one of the major drawbacks of Delphi method. (Hung et al., 2008; Murry and Hammons, 1995). Single measure of consensus was followed earlier, but to add more rigour to the method 2-3 criteria are used in recent researches.This could help overcome the problems associated with single measure of consensus.

Some of the measures of consensus are listed below (Birko, Dove and Özdemir,2015;Rayens and Hahn,2000; English and Kernan, 1976).

1. De Moivre index (DM): It takes a value of 0 or 1 only depending on whether all respondents have agreement in their opinion.

2. Interquartile Range:It is a measure of variability in data, which can be calculated by taking the difference between largest and smallest values in the middle half of observations.

3. Coefficient of variation (CV): It is the measure of relative variability calculated as the ratio of standard deviation to mean in a set of observations.

4.Pairwise Agreement: Pairwise Agreement is the corresponding average measure of pairwise agreement over all possible pairs of experts

5. Clustered Pairwise Agreement: Based on the pairs of agreement in each consensus cluster.

6. Extremities Version of the Clustered Pairwise Agreement: It is modifiedClustered Pairwise Agreement, it takes only the agreements falling in upper or lower bound of the scale (e.g., 1-2-3 and 8-9-10 respectively in our simulation).

English and Kernan (1976) reported that if the value of the coefficient of variation (CV) more than 0.5 and less than or equal to 0.8, it means less than satisfactory degree of consensus and there is possible need for additional round. If CV is less than or equal to 0.5, there is no need for additional round. Elwyn*et al*., (2006) opined that consensus will not be there if 30 per cent or more of the ratings fall simultaneously in the lower third and in the upper third of the scale. Hackett*et al*., (2006) considered Fifty-one per cent of experts responding to the highest category as the criteria of consensus, while Beattie and Mackway-Jones(2004) and Roberts-Davis and Read(2001) argues for agreement by more than 75 per cent of experts.The concept ofapplying more than one consensus criteria is based on the premises of methodological triangulation wherein the methods will substantiate one another (Creswell, 2007; Mason, 2002; Silverman, 2005).

**Number of Rounds**

The number of rounds in the process of iteration varies depending on the nature and purpose of the exercise. Normally, consensus is reached in two or three rounds (Delbecq et al.,1975). In case of heterogeneous audience, more rounds will be required. In case of homogenous groups, one or two rounds are sufficient. As the number of rounds increases there is a threat of reduction in response rate (Alexander, 2004; Rosenbaum, 1985; Thomson, 1985).

**Panel Size**

There exists no clear cut rule regarding the size of the panel. It depends on the nature of the study, degree of complexity, required precision and expertise. It can be large or small, geographically dispersed or confined, homogenous or heterogeneous etc. But the rule of thumb is15-30 people for a homogeneous population i.e., experts coming from the same discipline (e.g. nuclear physicists) and 5-10 people for a heterogeneous population, people with expertise on a particular topic but coming from different social/professional stratifications such as teachers, university academics and school principals (Delbecq et al., 1975; Uhl, 1983; Moore, 1987). According to Adams (2001), by increasing the size beyond 30, reliability and validity hardly improves. It has been pointed out that more than 13 respondents are suffient to achieve satisfactory level of reliability (Dalkey,1969). Hasson, Keeney,and McKenna (2000) points out that achieving impartiality in recruiting panel members is often difficult. There will be selection bias very often make a case for seeking impartiality in recruiting panel members, but this

**Survey Instrument**

Delphi questionnaires can be open ended or requiring response on 5-point likert type scale. In some cases, open ended questionnaires are used in first round to have sufficient information base. In the repeated round likert type scales are used based on the first round.

**Confidentiality**

Responses to the Delphi questionnaires need to be treated with complete confidentiality, and the anonymity of experts in panel was thoroughly maintained throughout the data collection.

**Mode of Communication**

The mode of communication may be on line or through mailed questionnaires. With the advent of Information and communication technologies there are many possibilities to fasten the process. The applications like ‘Google form and Survey monkey’ can be effective used for the purpose

**Statistical analysis used**

Descriptive statistical analysis such as mean, median, mode, percentage, interquartile deviation (IQD), standard deviation and coefficient of variation were used for analysing the data.

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# Chapter 27

## Input and service delivery system of extension of State Government

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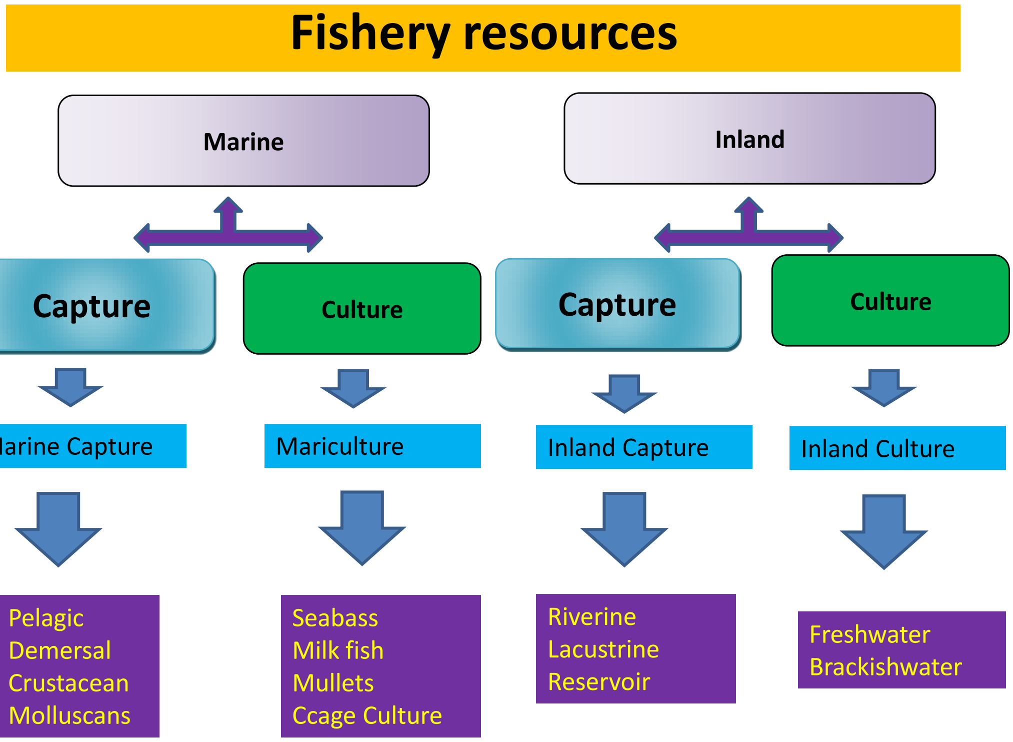
### Fisheries sector of Kerala

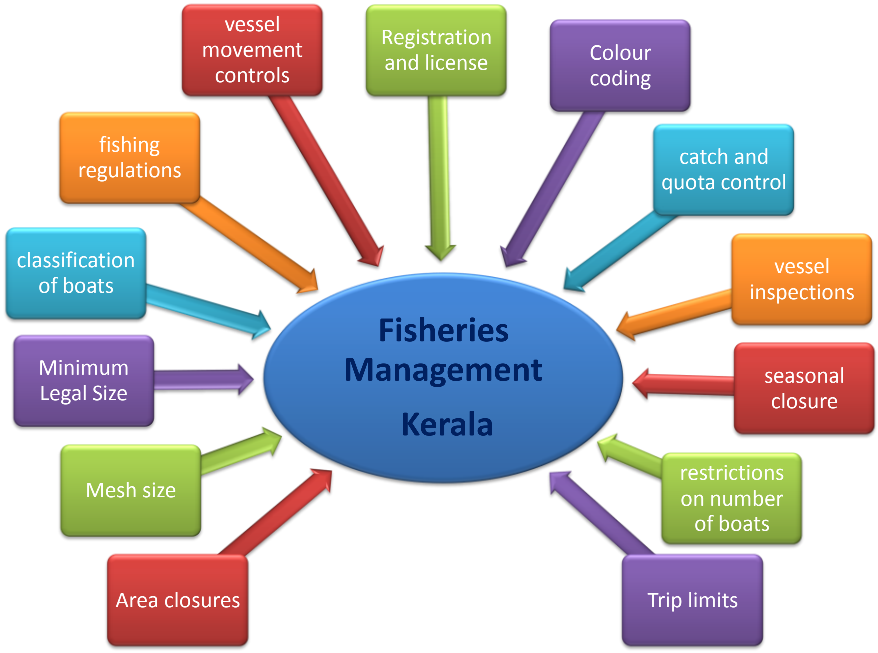
Estimated Fishermen Population in Kerala state for 2012-13 period was 10.07 lakh. There are 222Marine fishing villages and 113 inland fishing villages in Kerala state. There are 44 rivers and 11 Fishing HarboursNumber of registered vessels (as on 31-12-2013) is : Motorised non mechanical : 25542

- Motorised mechanical : 3435
- Non-motorised : 1799
- Total : 30776

Fishery resources in Kerala is pictorially represented as below



Fisheries management in Kerala is pictorially represented as below




**Kerala fisheries- contribution to economy**

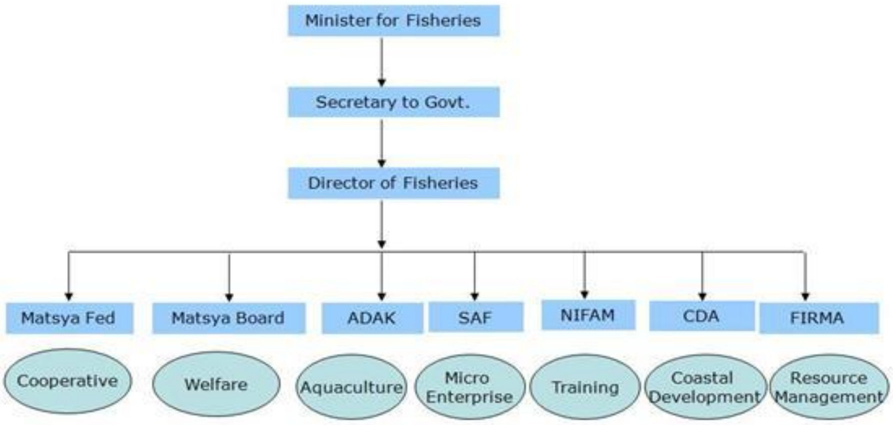
Share of fisheries sector to state economy is 1.46 % to SGDP, AGDP (4.6%) and 85% of the population are fish consumerswhich contribute towards Nutritional security – ( 97% reported). 10.24 lakh (3.1 per cent of the state population)people depend upon fishery as their Livelihood activity. Fish landings in Kerala is 5.88 LT( marine ) and 2.10 LT ( inland) with a Potential of 7.95 LT ( marine) and 3.5 LT ( Inland) . Annual production is 6 Lakh tonnes. GDP contribution – 14%

Per capita fish consumption is 27 kg and demand supply deficit- 30%. Export share is 15-18 %. Population and income growth rates, changes in food habits, increasing awareness on nutritional qualities of fish, improvements in transportation, storage and processing facilities and access to quality fish are prospects in fishery sector.

**Major fisheries resources**

Marine Caosatline is -590 kn and there are 9 caostal districts. Total estimated fresh water area is 3,32,000ha and Brackish water resources are :1.26 lakh ha. There is also wetland resource in the form of Pokkali fields of 12,500 ha

**Organogram of the fisheries department, Kerala**




- State level - Directorate of FisheriesDirector of Fisheries
- Addl.Director of Fisheries (Technical)
- Zonal level - Joint Directorate of Fisheries
  Joint Director of Fisheries (South/Central/North) - 3 Nos.
- District level - Dy. Directorate of FisheriesDy. Director of Fisheries - 10 Nos.
- Asst. Director of Fisheries - 4 Nos.
- Panchayat level - Matsya Bhavans
  Matsya Bhavan Officers - 200 Nos.

**Mission of Department of Fisheries**

- To promote, facilitate and secure the long-term development, conservation and utilization of both inland and marine fisheries resources based on responsible fishing practices and environmentally sound management programmes with focus on:
- Sustainable utilization of the natural fish resources
- Augmentation of fish production by aquaculture, exploration of new fishing grounds, promotion of low value fishes.
- Enhancing fish production and productivity
- Ensuring safe fishing
- Increasing livelihood opportunities
- Strengthening social security and welfare measures for fisher folk
- Fish resource conservation and management
- Facilitating improved post harvest practices and value addition with industrial and market linkages.

**Major schemes and services of Department of fisheries**

1. Conservation and Management of Fish Resources
2. Marine Fishing Implements
3. Integrated Fisheries development
4. Inland Fish Production
5. Fishing Harbours
6. Investigation of new fishing harbours and landing centres
7. Management of Fishery Harbour

8. Fish landing centres
9. RIDF
10. Modernisation of fish markets and value addition
11. Coastal social infrastructure.
12. Theeramythri and Micro enterprises
13. Education
14. National Fishermen Welfare Fund Assisted Housing Scheme
15. Group Insurance Scheme for Fishermen
16. Group Insurance Scheme for Allied Workers in Fishery Sector
17. . Extension and Training
18. Modernisation of Fisheries Departmen
19. 13th Finance Commission Award
20. Kerala University of Fisheries & Ocean Studies
21. .Coastal Area Development

**Fishermen welfare schemes**

- Education assistance & scholarship
- Life mission
- Housing schemes
- Sanitation schemes
- House repair
- Electrification
- Free ration
- Awareness class for fisher folk
- Medical camp
- Landless homeless housing scheme
- Rehabilitation of fisher folk from 50 mtr in costal area
- Adoption of fisher folk students
- Career guidance
- Saving Cum Relief Scheme to Fishermen

# Chapter 23

## Application of Economic Surplus Model for Impact Assessment: Case of Bt Cotton in India

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### Introduction

In the annals of Indian agriculture, Btcotton is a major technological landmark after the advent of green revolutionin late 1960s. Since the official legal introduction of the technology in 2002, it transgressed sizes and agro-ecologies resulting in significant economic gains, and transformed the landscape of Indian cotton scenario (Ramasundaram*et al.,* 2011). The direct benefits ofBt cotton include reduced insecticide usage, lower farming risks and production costs, better yields and profitability, expanded opportunities to grow cotton and a brighter economic outlook for the cotton industry (Edge *et al.,* 2000; Gandhi and Namboodiri, 2006; Pray and Naseem,2007). These benefits have transformed into increased returns to labour and aggregate household income, thereby contributing to poverty reduction (Subramanian and Qaim, 2010).

The noticeable feature of the impact of Bt cotton in India is its regionalvariationsdue to the underlying agro-ecologic and socio-economic differences(Bennett*et al.,* 2006,Qaim*et al.,* 2006).These incidences would be more pronounced when the prescribed norms for Bt cotton cultivation- like maintenance of refuge crops- are not strictly followed, asoften observed in small-holder agriculture (Sadashivappa and Qaim, 2009). Further, Bt seeds in India are available only in hybrids produced and marketed by private firms. Accordingly, some of the state governments in India intervened in Bt cotton seed pricing by declaring maximum retail prices for cotton seed, again with some inter-state variations. These developments have affectedtherelative performance of cotton in terms of yield growth, pesticide saving and seed costs. However, there is a very limited literature that deals with *ex-post*assessment of impact of Bt cotton at national (aggregate) level in India, as in case of many other non-industrialised countries (Falk-Zepeda *et al.*, 2007). Even scarcer are studies that address regional variations on the technology adoption and agronomic performance.

[1]Verbatim compilation from Ramasundaram, P., A. Suresh, J. Samuel and S. Wankhade (2014) Welfare gains from application of first generation biotechnology in Indian agriculture: The case of Bt cotton, *Agricultural Economics Research Review*, 27 (1): 73-82, and not to be re-used. Provided as a study/ reading material for participants of the ITEC sponsored training programme on “Extension management strategies for upscaling technology dissemination in Fisheries”, at Central Institute of Fisheries Technology, Kochi-29, during 9-22 November 2018.

The present study attempts to estimate the welfaregains of Bt cotton in India and its distribution acrossregions (states in India). Our research contributes to the existing literature in twoways: first, as noted earlier, there are only a few *ex-post*studies in India that attempted to document the welfare gains of Bt cotton cultivation to come up with national level estimates, taking into account the regional variations.Those studies used trial data or field level data on agronomic and economic performances, collected from experimental farms or a limited number of farmers from a particular locationat a particular point of time. We, on the other hand, combine the field level data with the macro level data on actual performance of cotton using the databases of Ministry of Agriculture, Government of India, for all major cotton growing states. Second, the study updatesprivate sector surpluses taking into account the changes in the input (seed) markets.

In the following section, we present a brief overview of the extent of adoption of Bt cotton in Indiaand its economic impacts and related developments. This is followed by description of the general features of the economic surplus approach and the model used in the study. In the subsequent session results of the study and the discussion are provided, while the last sessionconcludes.

**Extent of Bt cotton cultivation and its impact in India- Anoverview**

In 2009-10, cotton occupied 10.3 million ha, sustaining about 4-5 million farm households, with a raw cotton production of 5.5million tonnes (GoI, 2010). It is cultivated in most of the agro-ecologies, mainly under rainfedconditions,except in northern states, where it is cultivated with assured irrigation (Sundaram*et al.*, 1999). But Maharashtra, Gujarat and Andhra Pradesh account for more than three-fourth of the total cultivated area. Cottonhas attracted attention of Governments, researchers and activistsdue to its sheer contribution to the national exchequer and livelihood of millions of farmers and textile workers, with significant political implications, and, therefore, has undergone continuous technology and policy shifts over a period of time(Ramasundaram*et al.*,2012).During these shifts cotton has witnessed compositional changes in species mix. At the dawn of the independence, about 96 % of the cotton area was under *desi* (indigenous) varieties (Sundaram*et al.,* 1999). Commercial hybrid in cotton in the world was first developed by India in late 1960s. By 2000, the area under the American cotton varieties and hybrids reached 75 %. However, the yield advantage associated with varietal changes started dissipating over years and it exhibited signs of fatigue in increasing the yield. One of the major reasons was increased biotic stress particularly, pest attack. The most economically important pest that infested cotton crop was the American cotton bollworm (*Helicoverpaarmigera*). Considering the damage potential, farmers had to maintain near zero tolerance against this pest. Central Institute of Cotton Research (CICR), under the Indian Council of Agricultural Research (ICAR), Government of India, reported that theinsect pests in general causedupto 50 % losses in cotton productivity (1998). In many states, the share of plant protection costs in total cost of cultivation increased tremendously. For example in Punjab, the share of pesticidesin operational costs four perc cent in TE 1978-79 to 34 per cent in TE 2001-02and to about 50 % in some endemic areas (Shetty, 2004). Researchers estimatedthat the total loss due to the infestation of bollworm was to the tune of Rs 20 billion to Rs120 billion[2](Wahab, 1997; Chandra 1998;Birthal*et al.* 2000),despite about half of India's total pesticide consumption going for cotton alone(Sundaram*et al.* 1999;Qaim2003), mainly targeting American cotton bollworm. The human health implications of high chemical use in cotton cultivation were also enormous. These developmentswere creating a perfect stage for the introduction of transgenic cotton in India. After the introduction of Bt hybrids in 2002-03 Kharif, its adoption at an exponential rate was invasive and unparalleled; a brief review of the economic impacts of which, is provided below.

***Economic impacts of Bt adoption in cotton***

Many recent studies have examined the economic impact of Bt cotton in developing countries including India (Qaim 2003;Qaim and Zilberman2003;Huang *et al.* 2004;Barwale*et al.* 2004; Bennett*et al.* 2006;Gandhi and Namboodiri 2006;Qaim*et al.* 2006;Dev and Rao 2007; Pray and Naseem 2007; Vitale *et al.*2007). Most of these studies employed either and / or enterprise budgeting technique, production function approach and its variations, social accounting matrix, economic surplus model using primary data (collected from the farmers/ plots), and came out with varying estimates of the impacts, mostly leading to conforming results of the positive impacts and attributed the increased farm level benefits to savings from insecticide use, higher effective yields, despite higher seed prices (Subramanian and Qaim, 2010). Since its introduction, the area under Bt cotton increased from about 29 thousandhectares in 2002 to over 9.4 million hectares in 2010 (James, 2010), accompanied by an increase in yield from 213 kg/ ha (triennium ending average in 2000-01) to 430 kg/ ha in (triennium ending average in 2008-09). Table 1 depicts the estimated area under Bt cotton in major states in India between 2002 and 2010. The replacement of areas under non-Bt cotton coincided with significant yield increase across all the states.

Figure 1 depicts the yield increase of cotton in major cotton growing states of India since 1970. It is clearly observable that all the states posted sharp yield increase post- Bt cotton introduction. This has causedcorresponding production increase - from1.83million tonnesto 4million tonnesat an aggregate growth rate of about 13 % per year for both production and yield. This contrasts with the growth performance during the previous decade at about negative one %for yield and 0.7 %for production. The contribution of yield effect in the total production increase during the Bt period was about 83 % at national level, and surpassed 100 % in case of four out of nine major cotton growing states (on account of negative area growth) (Ramasundaram*et al.*, 2012).This is the single major factor that contributed towards the growth in cotton production (James, 2008).Nevertheless, thereexisted wide regional variations in growth performance. Table 2 depicts the area, production and yield growths during the Bt period and the preceding decade.

Yield growth was significant during the Bt period (from 2002-03 onwards)- ranging from 3.2 % in Tamil Nadu to 17.4 % in Gujarat -resulting in significant

[2]The exchange rate for Indian currency, Rupees (Rs) is One US$ = Rs 48.6 in 2002

production growthas well in all but two states. The low production growths in some states as could be noticed in case of Karnataka and Tamil Nadu can be attributed to fall in the area. The impact of Bt technology on cotton yield increasehas been succinctly broughtby Gruère and Sengupta (2011), in their observation that the average cotton yield level reached almost 400 kg/ha in 2003-04 (for the first time in history, even though the area under Bt hybrids was very less) and that the yield level exceeded 500 kg/haonly three years later in 2006-07, whereas it took 15 years, from 1982 to 1997, for the national yield level to increase from 200 kg/hato an average of 300 kg/ha. It was also estimated that in the alternate scenario of continuing only historical growth rates, the production would have been around 13-14 million bales at the yield level of less than 300 kg/ha as against 526 kg/ha during 2009-10. The total pesticide consumption in Indian agriculture would have been around 60 thousand tonnes against 42 thousand tonnes during 2010-11 (Ramasundaram*et al.* 2011). It is pertinent to mention that the advances in pesticide technology too might have contributed to this reduction.

Many other studies have estimated the beneficial role of Bt cotton cultivation, deploying field level data. Qaim*et al.* (2006) used farm level data collected from the states of Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu in 2002 and reported that Bt cotton yields were higher to the extent of 34 %with lower number of insecticide sprays (2.6 times less). Subramanian and Qaim (2009) surveyed the same farmers again in 2004-05 and in 2006-07, and reported that on an average Bt cotton recorded 37 % higher yields than the conventional cotton and 41 % lower insecticide applications. Narayanamoorthy and Kalamkar (2006) while examining the economic viability of Bt cotton cultivation at farm level, reported that the profit realized from the Bt cotton is substantially higher than that from the non-Bt cotton crop, to the extent of about Rs 14000, and the profit was about 80 % higher than that of the non-Bt farmers owing to higher productivity and cost efficiency than higher output price. Similar results were reported by some other researchers as well (Bennet*et al.*, 2006;Dev and Rao, 2007). But some other studies were rather skeptical about the impact of Bt technology in India. Kuruganti (2009) observed that the high yield growth in case of Gujarat was mainly due to the low incidence of the target pest, consistently good monsoon for a long period, increasing area under irrigation and high application of chemical fertilizers. Further, the author argued that the hybrid vigor brought about by the shift to cultivation of hybrids itself brought in large yield improvement. Large scale shift to hybrids ($F_1$ seed) was reported as an important after effect of Bt cotton cultivation in India (Khadi,2007). Naik*et al.* (2005),while exploring the paradoxes reported in some earlier studies on benefits of Bt cotton, found that on an average the technology generates overall economic benefits, but heterogeneity among farmers needs to be accounted for. The appropriateness of Bt technology depends on local pest pressure, individual crop management, local suitability of the germplasm into which Bt gene is transferred and the information flow. Gruère and Sengupta (2011), while agreeing to the proposition that the Bt cotton technology has played a significant role in raising the cotton production, also pointed to the differing marginal effects of the technology across states. Some researchers attribute such differences to the enabling paraphernalia of technology adoption like development of irrigation infrastructure (Shah *et al.*, 2009,Ramasundaram*et al.* 2012), besides the variations in the agro-ecological and socio-economic conditions (Bennett*et al.*, 2006;Qaim*et al.*, 2006). This fact becomes more evident while looking at the irrigation development *vis a vis* cotton yield (Figure 2). It is discernible that the yield of cotton was generally high in regions with larger area under irrigation.

**Empirical methodology**

*Economic surplus model for welfare estimation*

Economic surplus model has been widely used to quantify the welfare effects of genetically modified crops. It details how markets would respond to the introduction of the technology, by analysing new equilibriumusing a demand-supply framework. The model is governed by the well-established economic theory and assumes perfect competition as the basis for best outcome for the society. It is based on the premise that whenever new technologies are adopted on a large scale, the productivity increase will cause the crop supply curve to shift downwards, leading to changes in producer and consumer surpluses, which are measured in standard monetary units (Alston *et al.,*1995). The consumers derive their surplus from purchasing their bundle of goods at lower prices, whereas producers obtain surplus out of selling higher quantities in the market and by reducing production costs. Consumer surplus, in that context, represents the free resources that can be transferred to other sectors of the economy, whereas the producer surplus is the sum of additional rents that accrue to farmers' internal resources (Vitale *et al*, 2007). The magnitude and distribution of the economic benefits depend on factors such as price elasticities, volume of production, trade issues, and nature of innovative changes induced by the technology, innovator rent, and technology fee, among others. The model follows comparative statics approach, and doesn't detail the dynamics of establishment of the new equilibrium. One of the important features of the model is that, the early adopters will achieve large benefits that would dissipate as others follow (Vitale *et al.*, 2007).When the market for a single crop is considered, partial equilibrium models are used, whereas general equilibrium models are used when indirect effects and spillover to other markets and sectors are also of interest (Qaim, 2009). The present study covers only Bt cotton (although there could be some substitution effects between Bt and non-Bt cotton), and, therefore, adopt partial equilibrium model.The economic surplus model considers only the effects of the technology change in the market where the technical changes occurs, and disregards the effects in other markets, such as input markets. As the technology is developed and commercialised by the private sector, technology rent accrued tothem also needs to be considered (Moschini and Lapan, 1997) in estimating total welfare.The technology in India is developed by Mahyco-Monsanto Biotech, but the company have sub-licensed marketing rights to four other firms as well. Therefore, the appropriation of the benefits of the seed industry goes to all the firms involved in the entire business process, including the innovators and the marketing companies depending upon the license agreements and respective market shares. However, we restricted our analysis to the benefits accrued to the entire private sector without attempting to analyse the firm level benefit appropriation.

*Model empirical structure*

India is a net exporter of raw cotton and yarn. As on 2009, India exported 1.4 million tonnes of cotton (including raw cotton, cotton yarn, lint and waste) worth US

$ 2.0 billion. This accounts for 21 % of world cotton trade (FAO, 2011). On account of this significant share in export, we modelled the economic impact of Bt cotton in an open-economy framework with no technology spillovers (though, there could be some across the border transfer), and assumed linear supply and demand and a parallel shift in supply from the new technology (Alston *et al.*, 1995). The spillover effect is neglected considering the large size of India as an agrarian economy and negligent impact that the changes in factors of production would bring about in other sectors. The cotton market is regulated by Government of India, which guarantees purchase of cotton at minimum support prices. However, in practice, the domestic market price is higher than the minimum support price rendering the Government operations redundant in most of the years and states. The Bt cotton seeds in India is marketed by Mahyco-Monsanto, the holder of the patent for the technology and marketing rights. Due to this monopoly power the company enjoys, it could beableto set the seed prices above the marginal cost of production. Therefore, the welfare estimation undertaken in this model consists of two components, viz. the changes in the producer surplus and the monopoly profits. The change in producer surplus (Δ PS) resulting from Bt technology in the year t can be calculated as:

$$\Delta PS = PQK\,(1+0.5\,K\varepsilon) \qquad ...(1)$$

Where, P and Q are counterfactual cotton prices and quantities, respectively and ε is the price elasticity of supply. K is the technology induced supply shift of cotton, calculated based on the actual change in the yield level of cotton as indicated below:

$$K = \left[\frac{E(Y)}{\varepsilon} - \frac{E(C)}{1+E(Y)}\right]\rho A_t(1-\delta_t) \qquad ...(2)$$

Where, E(Y) is the proportionate yield change per hectare, E(C) is the proportionate change in variable input costs per hectare to achieve the expected yield changes, ρ is the probability of the success of the research (assumed as one as it is *fait accompli* and the analysis is *ex-post*), $A_t$ is the adoption of Bt cotton in percentage of total acreage and $\delta_t$isthe annual rate of depreciation. As the performance details of the technology were available, the field data with respect to yield advantage, cost reduction and adoption rate were used for estimation. The private sector benefit (PB) accruing to the innovators and marketers is analysed using the method propounded by Moschini*et al,*. (2000) as indicated below:

$$PB = A[(1-\theta)(P_{Bt} - P_{non\text{-}Bt})] \qquad ...(3)$$

Where, A is the coverage of Bt cotton in hectares, $P_{Bt}$ is the price of the $B_t$ seeds and $P_{non\text{-}Bt}$ is the price of non- Bt seeds. Here, it is safe to assume that the conventional seed market is competitive and cost of production of Bt cotton is equal to that of the non Bt conventional hybrids available in the market, and difference between these two prices is the gross technology revenue (GTR). However, distribution, marketing and extension cost of the Bt seeds is somewhat higher than that of the conventional hybrids, especially in the early years of adoption. Qaim*et al.* (2006) used a value of 0.1 to account for this expenditure and is represented by θ in the equation indicated above. By adjusting the GTR with θ, it translates intonet private benefit. Though this cost pertains to the initial years of the technology development, it is assumed that the expenditure under this head would continue to retain the market composition and introduction of new hybrids with Bt gene. The company R&D expenditure has not been accounted for in the analysis as they are considered as sunk costs. The analysis has been carried out for all the major cotton growing states of India. The producer and private sector surpluses were generated and summed up to arrive at the national figures.

***Data and data sources***

As reviewed earlier, many empirical studies have documented the economic benefits of Bt cotton cultivation in India, with mostly conforming results, leaving a few contradictions. Using meta analysis covering a fairly long period of 2003 to 2008, Gruère and Sengupta (2011) notedthat a majority of Indian farmers gained substantially by adopting Bt cotton; however, the gains in the Bt cotton cultivation cannot be generalised for all cultivators, regions and seasons. On an average,the number of pesticide sprays reduced by 30-36 % with associated cost reduction of 35-52 %. The yield increase ranged between 34-42 %, with no clear effect on seed cotton prices. The overall rise in net return was to the extent of 50-94 %. Significantly, there were considerable inter-state variationsas well. Notwithstanding the deficiencies of these studies, we have adapted the averages of the agronomic performance parameterscompiledbyGruère and Sengupta(2011) to computestate wise economic surpluses. The technology life reckoned for computation was assumed to be 14 yearsbased on discussions with crop scientists and seed companies.

Acharya and Agarwal (1994) reported that the price elasticity of supply for cotton in Southern India is 0.31 in the short run and 0.54 in the long run. Since the state-wise disaggregated elasticity of supply was not reported, we have taken the average elasticity of 0.43 as the medium-run elasticity, and this was used to calculate the reduction in marginal costs for all the states. The medium run supply elasticity of 0.43 was used by some other researchers also to estimate the economic impact (see, Qaim, 2003). One other important parameter used in the estimation process is the technology fee, which is the cost difference between the Bt seeds and non-Bt counterparts. Though the price of Bt seeds was on the higher side in the initial years, subsequent Government interventions, brought it down considerably (Sadashivappa and Qaim, 2009). Based on discussions with the seed dealers and farmers, it was assumed to be 52 %. The actual technology adoption rates were used for the estimation of benefits upto 2010 and the end year values were retained for the remaining period of 2011 to 2015. It is pertinent to mention here that this assumption seems quite tenable as the adoption of Bt cotton almost stabilised by the end of the last decade.

Another important parameter is the technology depreciation. Discussions and literature enable our assumption that the technology depreciation setinBt cotton since 2007 and would continue to decline during the projection period,even while retaining the edge over non-Bt counterparts[3]. The counterfactual cotton prices were calculated as the

[3] The technology depreciation in case of Bt cotton is noted in the form of emergence of non-target pests as the major pests thereby necessitating increased pesticide application. It is observed that once the Lepidopteron pests, like American cotton bollworm infestation diminished, new problems emerged in the form of increased infestation by various sucking pests.

three year weighted average prices based on the data during the pre-Bt period, 1999-00 to 2001-02. The impact assessment needs to take into account the growth not accounted for by the technology; therefore the output was adjusted for this by using the exogenous output growths. They were estimated based on business as usual principle, by compound annual growth rate of cotton production over a decadecovering 1990-91 to 2001-02, the period closer to the introduction of Bt cotton. Since thebenefits are accruing over a period, the future benefits needs to be discounted. Selection of proper discount rate assumes importance in this context. Kula (2004) reported that the social discount rate for evaluating agricultural projects as 5.2%. We have adopted this rate to calculate the present value.

**Results and discussion**

*Welfare generation*

The welfare generated across states is provided in Table 3. The total welfare amounted to Rs 220 billion, consisting of Rs188 billion producer surplus and Rs32 billion private sector surplus. On conversion of the benefits into US dollars at 2002 exchange rates, it turned out to be $ 5.67 billion with per annum benefit of $ 404 million. Similar results were reported for other countries as well. Price *et al.*(2003) reported annual surplus of about $ 164 million in case of United States and the percentage shareamong farmers, consumers and producing companies were37, 18 and 45, respectively. For China, the surplus accrued was $140 million in 2009 (Pray *et al.*, 2001). Qaim (2003) estimated total producer and innovator surplus in India to be Rs 15 billion during 2005, starting from Rs 0.30 billion for 2002, Rs 2.1 billion for the year 2003 and Rs 6.0 billion for 2004, when the area under the Bt cotton was very low.Ourestimates are pegged at slightly lower level- Rs0.64 billion for 2002, Rs0.85 billion in 2003 and Rs 1.37 billion in 2004. This deviation wasmainly due to less than expected reduction in the pesticide consumption in some states. The realisation of the surpluses across states varied widely in proportion to the penetration of Bt hybrids, their agronomic performance and variations in pre-Bt cotton performance (base effect). The highest was recorded inMaharashtra, with Rs74 billion, accounting for about one third of total surplus, followed by Gujarat withRs67 billion, accounting for about 31 %. These two states together accounted for 57% of total cotton area in India (as on 2008-09). Andhra Pradesh, with its meagre share of only two per cent in surplus (pegged at about Rs 6.3 billion) is conspicuous as its share in the crop acreage is as high as 15 % (1.4 million hectares). The stateappropriatedonly 0.29 % of total producer surplus generated in India, while its share in total private sector surplus was 14 %. The lower performance of the producer surplus despite higher adoption rates may be due tothenegligible cost reduction and high pre- Btgrowth performance experienced in the state. Punjab, a state where cotton is cultivated under assured irrigated condition realised a producer surplus of Rs37 billion accounting for about 19 % of the total producer surplus, despite a meagre area share of about 5.6 %. The introduction of Bt cotton hybrids fitted very well with the prevailing cotton- wheat crop rotation systemof the state (Ramasundaram,2005). Short duration cotton could be cultivated during the *kharif* season (summer, starting from June- July), and harvested by about October, when the land preparation of the succeeding wheat crop during *rabi*season (winter, starting from late October) could be undertaken. Punjab is a major wheat producing state in India with the highest per hectare yield contributingmore than 20%to the national production as on 2010. Before 2005-06, the hybrid cotton area in the state was less than 3-4 %as open pollinated varieties were more preferred. But Bt hybrids with synchronised flowering, limited picking and early termination, enabled timely sowing of wheat.Besides, the dismal pre-Btperformance of cotton - the yield growth during the previous decade being negative (–3.2 %)due to severe pest infestation (Ramasundaram*et al.* 2012)- also facilitated a higher surplus. Bigger reductions in pesticide costs and resultant high yield advantage during the post-Bt period helped the state to emerge as a high performer.

It may be noted that almost 85 % of the total surplus generated was accounted for by the producers, and the rest by the private sector. Barring Andhra Pradesh, the share of producer surplus ranged between 76 % in Haryana and 90 % in Rajasthan (Figure 3). It is worthwhile to recall that in both these neighbouring states cotton is cultivated under irrigated condition. Still, the better in performance of cotton in these two states can be adduced to the higheryield gains and the pesticide reduction post Bt-introduction. The extent of surplus realisation and distribution between producers and private sectorwouldhave been different, but for the state intervention in rationalising the seed prices (Ramasundaram*et al*, 2011). The administrative measures to reduce the per acre seed pricefromRs 1500 to Rs 750 in many stateshelpedits wider adoption, generating higher producer surplus, and boosting the private sector surplus through volume of trade.It can be surmised that the percentage of benefit appropriation was more than the corresponding area share under Bt cotton in three out of nine states (Gujarat, Punjab and Rajasthan). While in Punjab and Rajasthan, large yield increase and pesticide reduction favoured an increase in the benefits, in case of Gujarat it was triggered by large area increase. Though cotton is cultivated under full irrigation coverage in Haryana also, the percentage benefit realisation could not surpass the area share, probably due to the less than proportionate reduction in input application compared to the non-Bt era.

The distribution pattern of the cumulative surplusesat national level over years for the period under study is depicted in Figure 4. It can be noted that by 2007, total surplus realisation was about 10 %, which increased sharply to 21 % by 2008, and further to 33 % by 2009. The year 2010 saw the realisation of almost half of the total cumulative surplus, and itemerged as the turning point, with no further marginal increase in the annual realisations. This would be mainly due to technology depreciation and diminished scope and progress infurther technology adoption. This warrants further investments for technology re-invention. Already such efforts are on, primarily by private sector. One of the prime steps in this regard was transfer of Bt gene to better host hybrids/ varieties and incorporation of genes that can withstand some other pests as well (stacked genes).

**Conclusions**

It is a decade since Bt cotton has been introduced for commercial cultivation in India in 2002-03. This study is contextual in critically analysing the impact of the technology on Indian cotton economy through an economic surplus model and examining the welfare distribution over states. The study combines the field level data on the agronomic performance of Bt cotton with the macro data on technology adoption, seed prices and exogenous growth rates for all the major states.

Bt cotton phase has increased income and generated substantial social gains due to higher yield and lower cost of production through reduced cost of plant protection. The total benefit would be Rs 220 billion with 85 %accruing to producers. The wide inter-state variations are because of the differences in the penetration of Bt hybrids, their agronomic performance in the fields and variations in pre- Bt cotton performances. It was noted that the highest total surplus was recorded in Maharashtrafollowed by Gujarat. Andhra Pradesh and Punjab depicted contrasting performance because of the differences in agronomic performances and the exogenous technology growth. While the lower reduction in insecticide usage combined with positive exogenous technology growth yielded a reduced producer benefit (in absolute terms and in comparison with the acreage) in case of Andhra Pradesh, the significant reduction in insecticide usage and lower exogenous production growth yield higher and more than proportionate benefit in case of Punjab. The private sector benefit, though was Rs32 billion, constituted only 15 % of total benefit. One reason for this might be the seed market regulations brought about by the Government. It is also worthwhile to point out that the relatively stronger intellectual property rights regulations in India helped generation of substantial private benefits and innovation rents, thereby promoting further private investment in research and development. It may be recalled that in India the vehicle for Bt technology in cotton is hybrids, whereas in other countries Bt technology is incorporated in open-pollinated varieties obviating the need to purchase seed every year (Ramasundaram*et al.,* 2011). Development of the open pollinated Bt varieties may help in realisation of greaterbenefits to cultivators in resource poor regions not conducive to hybrids and enhancement of the producer surplus. It is pertinent to note that the entire welfare generated cannot be attributed to the Bt gene technology alone, but to a gamut of other factors like increase in crop area, hybrid area, input use,favourableagroclimate in terms of consistent good rainfall in some regions, increase in the irrigation coverage, to cite a few.Hence, the entire benefit is better viewed as the welfare generated during the Bt phase.

However, the benefit estimatemay be an under report by as much as the un-estimated positive externalities and indirect benefits in terms of health benefits due to reduction in pesticide use and reduced exposure to pesticides, possible surge in predators and parasites population, improvement of soil health and clean water bodies, reduction in greenhouse gases, increase in employment and reduction in poverty, which cannot be captured due to paucity of data and time. On the flip side, new challenges have emerged in cotton pest scenario in India in the past few years, in terms of negative externalities like surge in minor pests calling for more plant protection expenditure for their control than earlier, reduction in biodiversity by elimination of cotton open pollinated varieties, to cite a few. This study has not taken into account these complex changes at field level. There is scopeforfurtherincreasing the social gains through research in various aspects of the crop. They include cost cutting strategies like promotion of Bt varieties for resource poor regions, demand driven value addition in fiber traits, incorporating stress tolerance traits andmanipulation of crop duration, among many others.

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## Chapter 24

### E-marketing of fish: Scope and Dynamics

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Indian fishery has established as one of the fastest growing enterprising sectors in India and contributes 1.1% to national GDP and 5.15% to agricultural GDP of the country. With more than 14 fold increase in national fish production in just six decades i.e. from 0.75 million tonnes in 1950-51 to 11.41 million tonnes during 2016-17; India registers an unparalleled average annual growth rate of 14.8% in fishery that establishes its position as second largest in global fish production, next to China. In fact, the fish production in India has been doubled during last two decades (between 1995-96 and 2014-15) that engages more than 14.5 million people in fisheries activities for their livelihood giving a boost to foreign exchange earnings to the tune of US $7.08 billion (2017–18) through export of 13.77 lakh MT fish and fisheries products, which amply justifies the importance of the sector on the country's economy and in livelihood security.

Seafood is considered as an important part of a healthy and balanced diet by most consumers. It’s been estimated that around 60 per cent of the Indian population consumes fish and the consumption pattern varies widely and across the different social fabric (Shyam, et al. 2013). The annual per capita consumption of fish for the entire Indian population is estimated at 5-6 kg whereas for the fish eating population it is found to be 8-9 kg. Average annual per capita fish consumption is highest in Kerala state at 30 kg which is very high compared to that of other states of India (Shyam, et al. 2015).

However, Indian consumers are forced to buy fish from unhygienic markets and vendors. In general, the fish supply chain follows a four-day cycle, wherein all parties don’t necessarily conform to scientific food safety norms. Without a proper cold chain, bacterial contamination typically starts within 30 minutes. Poor quality ice and preservatives like sodium benzoate and formalin are used to keep the fish from deteriorating, which are potentially harmful and carcinogenic for humans (Ranganna, 2017). In recent times, the wide scale media highlight on fish adulteration has created an increased health concern and consciousness about safety and quality standards among consumers (Sajeev, 2018a). These issues have created new drivers and barriers to fish consumption with fish consumers changing their fish purchase behaviour and market choice. Fish vendors air concerns about urban consumers' inhibition to purchase from traditional markets due to increased safety and quality awareness. In this context, online fish marketing has emerged in a big way and is assumed to be disrupting traditional fish vending business (Sajeev, et al. 2018).Online fish marketing claims to provide fresh and chemical/pesticide free fishes, which gives them an edge over other fish retail sources. There is a steady rise of e-commerce fish marketplace that has gained momentum with the rise of e-grocery and advent of new cost-effective freezing technology (Vishal, 2015).

**Online fish marketing**

Fish vendors doing business online sounds crazy in India where vendors have a virtual monopoly over door sales of both sea and inland fish. Moreover, fish being a highly perishable product, the idea was found too difficult to implement unlike other consumables where online marketing rules the roost. However, things changed drastically over the last couple of years particularly in urban areas.

Often referred to as ‘online marketing’, ‘internet marketing’ or ‘web marketing’, digital marketing/E-marketing has gained popularity over the past decade. With the arrival of social networks, e-marketing now also boasts of a new branch of social media marketing. Even though the term ‘digital marketing’ was coined in the 1990s, its complete usage and importance has risen only in the recent past. As technology advanced rapidly over the past two decades, digital media became so widespread that anybody could access information anytime, from anywhere.

E-Marketing stands for electronic marketing, is also known as Internet marketing. In contrast to traditional marketing, E-Marketing takes marketing techniques and concepts, and applies them through the electronic medium of the internet. Essentially, E-marketing threads the technical and graphical aspects of online tools together, allowing for design, advertising, brand development, promotion and sales. Internet marketing offer the possibility to tracking almost every action a visitor or potential customer takes in response to marketing messages and how they navigate through their buying cycle. One of the most desirable aspects of Internet marketing is low barrier to entry. “Digital marketing/e-marketing as the name specifies is marketing over the internet through various digital devices".

Online marketing giants such as Amazon and Flipkart have been showing tremendous growth over the years in Indian e-retail market space. Hence, idea of e-markets is not new for Indian customers and they have become used to it. But fish being a highly perishable commodity, adhering to quality standards makes its sales, marketing and promotion a risky affair. Sustenance of online fish marketing depends on providing fresh and affordable fish to the consumers on time. This distinguishing factor makes online fish marketing an interesting topic of study.

With an increased knowledge, attitude and better perception about health, quality and safety issues related to fish consumption, customers are fast switching to online fish markets.Orders are just a touch away on android mobile apps, websites, facebook page, Whatsapp message, an SMS or a call. More than a dozen e-commerce sites; www.freshtohome.com, www.dailyfish.in, www.mathafreshfish.com, www.suvichar.in, www.onedaycart.com, www.freshandhealthy.in, www.wildfish.in, www.biggro.com, www.healthyfishonline.com, www.onedaycart.com, www.onlinekochi.com, www.nallameen.com, www.bigbasket.com etc are into business and is expanding their market base day by day (Cynthia, 2016). These fish E-commerce sites offer a rich array, mostly the variety available on local coast. Pre-ordered fresh fish reaches consumers’ doorstep in curry cut, steak, fully cleaned or even as whole fish at prices affordable to the discerning homemaker. More than price, the focus in e-marketing of fish is on quality and safety (Sajeev, 2018b). Some online sites charge for delivery while others do it for free.

Traditional digital marketing has a communication mix which is the adaptation of place, product, promotion, and price in the digital context. As the number of internet users grows, so does the reach of your product, brand or services. This can be achieved through various techniques such as search engine optimization, search engine marketing, pay per click, web analytics, integrated marketing communications, etc. This chapter describes the various common digital marketing tools that are presently employed by entrepreneurs in e-marketing of fish and fish products.

**1. Keyword Strategy**

A keyword in digital marketing is defined as a word or phrase used by a person to gather information on a topic online. Usually people enter the keywords in search engines like Google, Bing or social media sites like twitter, facebook, LinkedIn and so on to hatch the information they are looking for. Marketers need to make sure that right people are finding them and they are not wasting money on useless clicks. Keyword research is an ongoing process that gives us insights on product demand and industry trends. One can grow their organic traffic and can prevent spending money on Pay-per-click campaigns through comprehensive keyword research. Keywords used by fish marketers include fresh fish, fresh fish online, fresh fish online Kochi, fish online, daily fish online etc. It was found that all the online fish sellers have used this strategy.

**2. Search Engine Optimization**

Search Engine Optimization is the way toward enhancing rankings of a site or website page in the unpaid search lists. The way of the SEO is to make website pages rank higher in the search engine result pages (otherwise known as SERPs) to increase visibility, authority and Alexa scores. The higher a page positions, the more striking and unhidden it is, and along these lines will get more activity, traffic, and conversions. This strategy is employed by almost all big e-commerce websites and few major players in fish e-marketing.

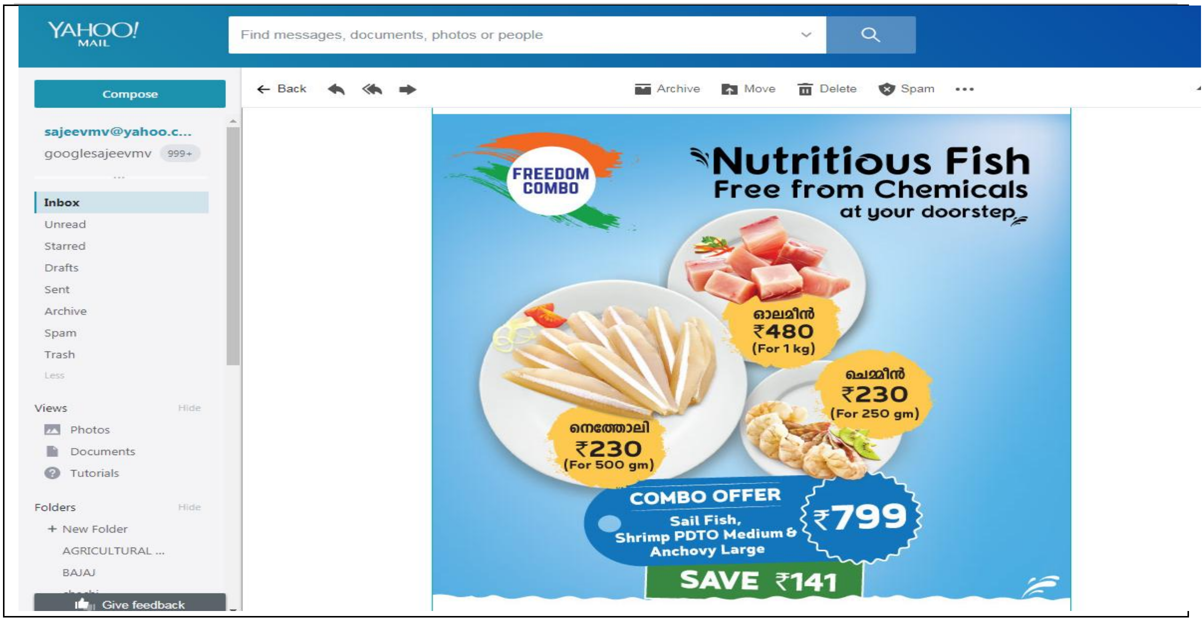
**3. Pay per Click (PPC)**

As an effective type of online marketing, Pay per clicks is one of speediest types of marketing channels to drive targeted traffic to your web pages and related services. Pay per click promotions are no longer displayed on the sidebar on search engines, and now they are shown on niche sites, or are also shown as sponsored stories on different social media networks. PPC ads are shown as product listing, or as a video ad. They are focused on, either via a search term, or by the site on which the pay per click promotion is shown or also by the profile interests. Most online fish marketing firms like Daily fish, Healthy fish and Fresh to Home etc use this method very frequently.

**4. E-mail Marketing**

Considered as one of the most important types of digital marketing channels, email marketing can be understood as the bridge between the highest point of your business channel (Awareness– SEO, Social Media, and Internet Networking) and related sales. Certainly, email is now not as hot as Social Media, yet it’s a standout amongst the most immediate and private types of correspondence. Along these lines, it is yet a standout amongst the best types of marketing channels in terms of optimizing sales by ensuring engagements.

The fish e-retailers haveused the private way of email correspondences and have taken care to treat their email subscribers somewhat more special compared to non-subscribers. This is made possible by offeringaccess to elite content, unique email subscribers' rebates, customized bargains, or other "insider" products not available to the outside audiences.

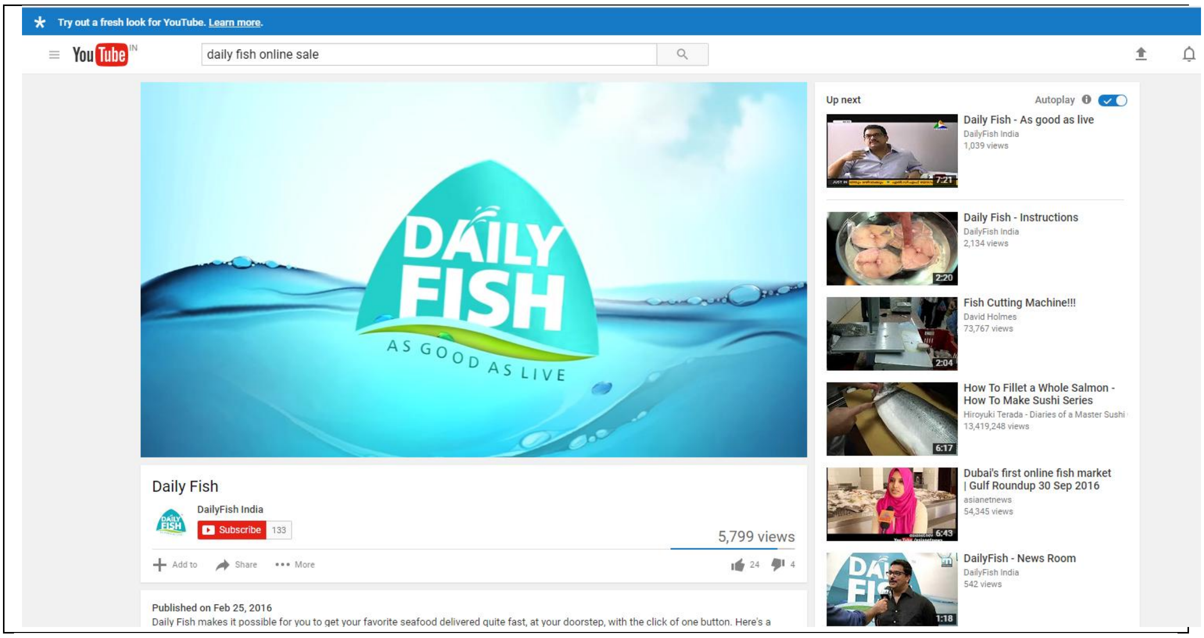



Appropriately set up email campaigns permits e-marketers to make fully targeted messaging that lets them comprehend where their client is in the purchasing cycle. Making email campaigns for each phase of the client lifecycle permits to develop loyalty and more conversions. Most online fish marketing firms like Daily fish, Healthy fish and Fresh to Home etc use email marketing on a daily basis to engage and attract their customers.

One significant hindrance for email advertisers is the steady development of spam channels in email programs. Firms should likewise make guarantee their marketing program does not disregard spam laws.

**5. Video Marketing/YouTube Marketing**

YouTube is the second biggest search engine on the planetwhilewebsites are the third most. Video can be amazingly social, and brilliant video advertisers are obscuring the lines of what's adequate for branded content. Videos act as one of the most interactive types of online marketing.




Take for instance the Daily Fish YouTube channel. The 'fish capture to fish delivery at your home' video makes extraordinary utilization of technology to convey its message, and the "business" side is practically optional to the objective of making you overwhelmed. This method is less popular now due to the fact that firms need to get the best possible training before taking their video marketing endeavours to next level where they can ensure great profits for investments. Video marketing/Youtube marketing of fish is still in a nascent stage with only two major firms found to have attempted this method.

## 6. Blog Marketing

It may appear to be abnormal to see blogging on this chapter, in light of the fact that a considerable lot of the things we've discussed may appear typified in blogging. Regardless, a blog is only a channel. It can have recordings, podcasts, content articles, news subjects, offer affiliate marketing, give guideline or knowledge and it incorporates content that fills the channel.

Blogging makes to the list of different types of online marketing channels on the grounds that dealing with that channel is truly an expertise all alone. Planning content, labeling and ordering content properly, overseeing interior linking, upgrading navigations – these are only a modest bunch of things that a genuine "blogger" need to oversee.

Blog administration is basic to the achievement of the blog as its basic structure is the thing that aids search engines list your blog for the content you need to be known for, and guests to go to proper pages inside your webpage. Blog marketing is not available in fish e-tailing but is used by a few firms to supplement and support their business through websites and social media by providing various fish recipes in detail through the blogs.

## 7. Social Media Marketing

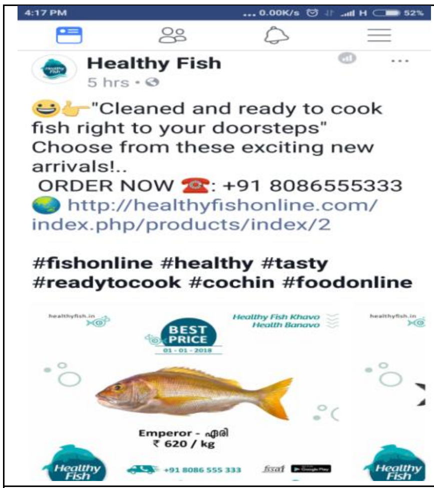
Amongst different types of online marketing, Social Media is youngest and as appealing as innovative and powerful. Most online fish and fish product sellers (50 percent in Kerala) have grasped the utilization of social stages to advance their brand image. Moreover it is the cheapest and best platform to advance ones business without spending a bomb on costly websites and advertisements. If an entrepreneur has to characterize the beginning procedure of social media promotion: he/she should look at different web-based online channels as any traditional media.

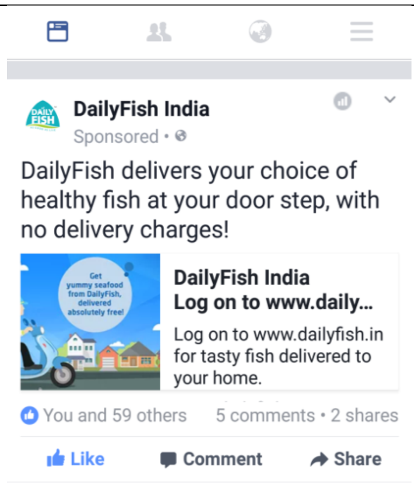


This would mean observing, learning and utilizing the typical social networking sites like – Facebook, Whatsapp, Instagram, Twitter, YouTube, LinkedIn etc. – however then additionally there are niche networks, forums, discussions, dynamic blog groups, and wherever there’s dynamic two-way discussion happening.



In these types of online marketing channels, firms would look for target audiences and give careful consideration to the dialect they’re utilizing, the inquiries they’re asking, and the substance they’re sharing. Famous online fish sellers like daily fish, fresh to home, one day cart and healthy fish are actively available on Facebook, Twitter and Instagram showcasing their daily catch and variety to prospective customers.






Examples of fish marketing through facebook.

The even more usually rehearsed social media strategy is “create & then distribute” in a well-targeted manner. Maybe the most abused approach used by online advertisers is to share ‘everything to everybody’ approach. By utilizing a more vital and figured social media plan, fish-preneurs can create social media communication that helps them construct a considerably more extensive gathering of people after some time.

**8. Websites**

In this modern era, customers are on the internet for information. People visit a website primarily to find information. In the online fish business world, information is critical. Online fish sellers need to have a website for customers whichcontain information about varieties and choices theyoffer. All the online fish sellers have a well-developed and established websites and apps. However if websites are unaffordable, the entrepreneurs can still opt for social media marketing. Below are just a few advantages and benefits why fish sellers choose online platforms for their business.

**9. Mobile Apps**

A mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobiledevice, such as a smartphone or tablet computer. Mobileapplications frequently serve to provide users with similar services to those accessed on PCs.Just like websites these too are expensive but once made, provides great value to the firms by attracting and engaging customers round the clock.

**Advantages of online fish marketing**

**Less Expensive**

Print media, radio, television or other traditional means are highly expensive. Investing in advertising is necessary, but it takes a lot of money. Having a website, apps and social media presence makes advertisement and sales less expensive. Many versions of offline advertising available on the internet are sometimes free.

**Advertising**

Online advertising is more environmental friendly when it comes to advertising and marketing. There are lots of ways to advertise products or services through the internet. One example is Facebook ads, an advertising feature offered through Facebook. Another one is called SEO. This is a major advantage for businesses. Having a good SEO service provider can boost the ranking of website which quickly results in increased sales and higher profits.

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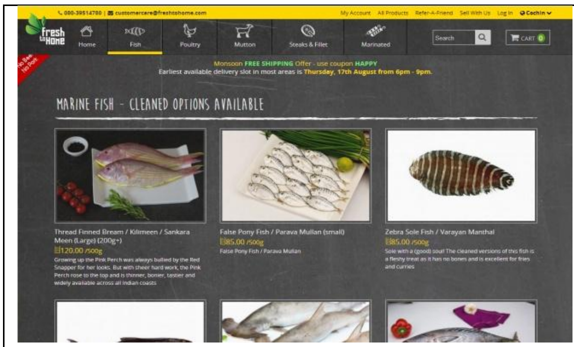
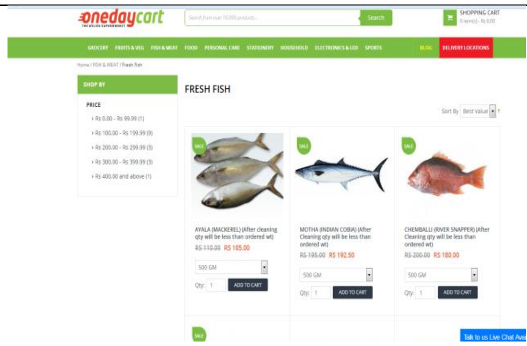
|  |  |
| Website of 'fresh to home' | Website of 'one day cart' |

**Satisfaction**

Having anonline platform will be more convenient for customers and for getting leads. It makes it easy for customers to purchase from retailers. Many will be more likely to visit afish selling website, rather than driving a car or two-wheeler to the physical location and shop for products. From a customer's point of view, it's better for them if they don't have to ask anything. They can just find what they're looking for on the online site.

**Increase Customers**

Most businesses have local popularity, but what about potential customers outside their city? A website can help generate more customers. The internet offers a global community. With a website, business will be visible around the world even though it is not useful for an online fish selling.

**Accessibility**

Firms always experience having to turn customers away because it's closing time. An online platform can be visited any time of the day or night. People will look to a site instead of going to their shop because it is more accessible. Firms have to just make sure to post enough information about their products.

**Access to Information**

By owning an online platform, companies can actually track everything that is happening on it.They can even look for information that will tell them how many people visited their site, or how many people messaged or emailed them. They can access the progress of their website or social media platform and view all its pages. They can make an update anytime, making it much less expensive than printed material.

**Better Relationship**

Having an online presence can build better relationships with customers. Firms can send messages instantly to customers through email. Also, customers can review products online and can also leave feedback for the business. Companies can give customers more information about your business through messages or emails.

**Increase Sales**

Online fish sellers can drive more people to their site by consistently updating and promoting the contents of their site. The more informative the site is, the greater the possibility of increasing sales.

**Opportunity**

Online platforms give you the opportunity to prove credibility. Firms have to tell customers why they deserve their trust through theirplatform. This can earn positive feedback for the service and products.

**Long Term Clients**

A customer is the one who walks in and buys something and that's it. A client is a regular customer. He/she is buying products or services daily or contractually. Having a website gives firms a chance to gain more clients that can help their business grow.

**Conclusion**

Online marketing is a dynamic kind of marketing that is at a nascent stage in India and is constantly evolving and changing. It is gaining momentum with focus on quality and convenience rather than price advantage (Sajeev, 2018b). Hence, with unmatched consumer accessibility through web, mobile and social media platforms and options for wide range of products and quick home delivery systems, online fish portals have started disrupting traditional fish vending in urban India. Online fish marketing is here to stay and calls for conclusive studies to be taken up to prove their disruption capability.

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# Chapter 25

## Supply chain management in fisheries

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The issue of the supply chain has been given much attention in recent decades, both in the academic as well as in the business world. Supply chain is defined as the sequence of processes involved in the production and distribution of a commodity. It is a network of producers, wholesalers, retailers, distributors, transporters, storage facilities and suppliers that participate in the production, delivery and sale of a product to the consumer.

Supply chain is a system which encompasses organizations, people, activities, information and resources involved in moving a product or service from supplier to consumer. It is a complex and dynamic supply and demand network of particular commodity/ product. Supply chain is a combination of three functions i.e. procurement of raw materials, production process and distribution. It is the process of evaluating the various stages of a business till it reached the consumers. It included evaluation of every step, starting from purchase of raw material and the processes and actors in between until deliver to the hands of consumer. It comprises of refining the activities with the aim to enriching consumer satisfaction level. The basic aim is to make the system more flexible that ultimately respond to better consumer preference.

Supply chain is comprised of various mid-chain actors viz., producers, processors, wholesalers, retailers, transporters, head load labourers and consumers. Supply chain mapping is the process of representing the selected supply chain either geographical or an abstract network design. This consists of various analysis i.e., stakeholders analysis, problem analysis, objectives analysis and strategy analysis. These analyses were aimed at identifying different individuals associated with the supply chain, cause and effect and means and end and also strategies for improving the existing supply chain.

**Fish supply chain**

Fish supply chain is the set of inter-dependent fishers, agents, processors, distributors, wholesalers and retailers including consumers in the line of transporting fish from landing centre (production point) to the consumer markets (market site). The landing centers serve as primary markets and the wholesale markets situated at a distance away from actual fish landing centers act as secondary markets. Retail markets are normally closer to the consumer. In some cases, wholesale markets have a separate retail section. New supply chain model is an advanced type of traditional supply chain which incorporated the feedback and information flow mechanism into chain. This is based on push strategy that includes consumer demand and feedback.

**Supply chain as an integrated system**

Supply chain is the integrated system of processes such as, acquiring raw material, transforming raw material into finished products, add value to the products, distribution and promotion of products and facilitate information exchange among functionaries. The supply chain contains two processes such as, material management (inbound logistics) and physical distribution (outbound logistics). Material management comprises of acquisition and storage of raw materials, parts and supplies. It supports material flow from raw material supply to distribution of finished products. Physical distribution encompasses activities related to better consumer services.

A supply chain comprises of multiple stakeholders (many suppliers, processors, third party distributors, retailers and consumers). They added that the success of supply chain depends heavily on availability of timely information that should be shared between members of the supply chain. The supply chain perspective involves the analysis of product and the actors (producers, wholesalers, retailers and consumers). This is faced with lot of issues and challenges i.e., trade, traceability, transparency, product quality & safety and consumer information. A supply chain has three key parts i.e., supply, manufacturing and distribution. These are explained below.

- **Supply**focuses on the raw materials supplied to manufacturing units.
- **Manufacturing** focuses on converting these raw materials into semi-finished / finished products.
- **Distribution** focuses on ensuring these products reach the consumers.

The main objective of the supply chain analysis is to produce higher quality and efficiency by co-operation rather than integration. The fish supply chain is a set of interdependent agents (fishers, processors, distributors and retailers) work together to convey the fish to the consumers. This has acquired complexity due to growth of international fish trade. The peculiarity of fish supply chain is that it does not concern of supply of products only, but it is a series of interconnected flow of goods, services, incentives and information between the market functionaries in the market chain. The co-operation and co-ordination of supply chain is essential for an effective supply chain. Now-a-days, the fisheries sector problems are becoming more complex due to multiplicity of challenges. This can be solved with the effective co-ordination of action and activities by the market functionaries. They added that both, the cooperation and coordination sides of supply chain management to be simultaneously handled.

The three parts of supply chain are the details about supply, manufacturing and distribution. The supply includes the details about raw materials that includes how, when and from where the raw materials will be supplied. Manufacturing part includes the details about conversion of raw materials into semi-finished products. At the last, the distribution part includes the network of market function till reach the consumers. In other view, it is the quantitative analysis of inputs and outputs between firms or markets along the chain which traces the complete sequence of operations from producer to consumer.

FAO (2005) highlighted two major tasks of any supply chain analysis. These are,

i. Mapping of the chain using flow chart: It includes overview of the chain, product flows and position of actors and their interactions.

ii. Developing of economic accounts corresponding to the actors: This is activity of quantifying the activities in terms of physical and monetary terms.

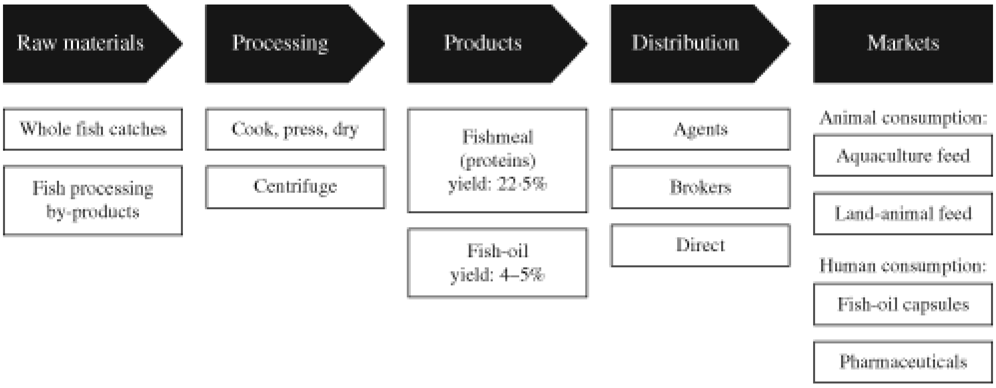



**Fig.1 Steps in supply chain analysis**

It is a key tool in improving operational efficiency. In general, the marketing channel of fish is very short due to the nature of perishability and non-availability of transparent price negotiation system. Generally, there are two types of measurements used to evaluate the overall performance of supply chain that includes financial and non-financial. The financial measures consider the economic and financial attributes and the non-financial measures considered operational attributes. Supply chain management is explained by various attributes, methods and techniques which is applicable to fishery products too.

**Attributes used in SC performance analysis**

There are certain attributes used towards explaining the supply chain and its performance. An attribute is defined as, "a set of metrics that are used to explain a competitive strategy to assess the supply chain performance. It is an ability of the SC ability for deliver products and services with good quality, on time, in precise amounts and minimizing costs". There are certain attributes used in supply chain performance analysis viz., performance, delivery, information, processes, operations, service and cost.

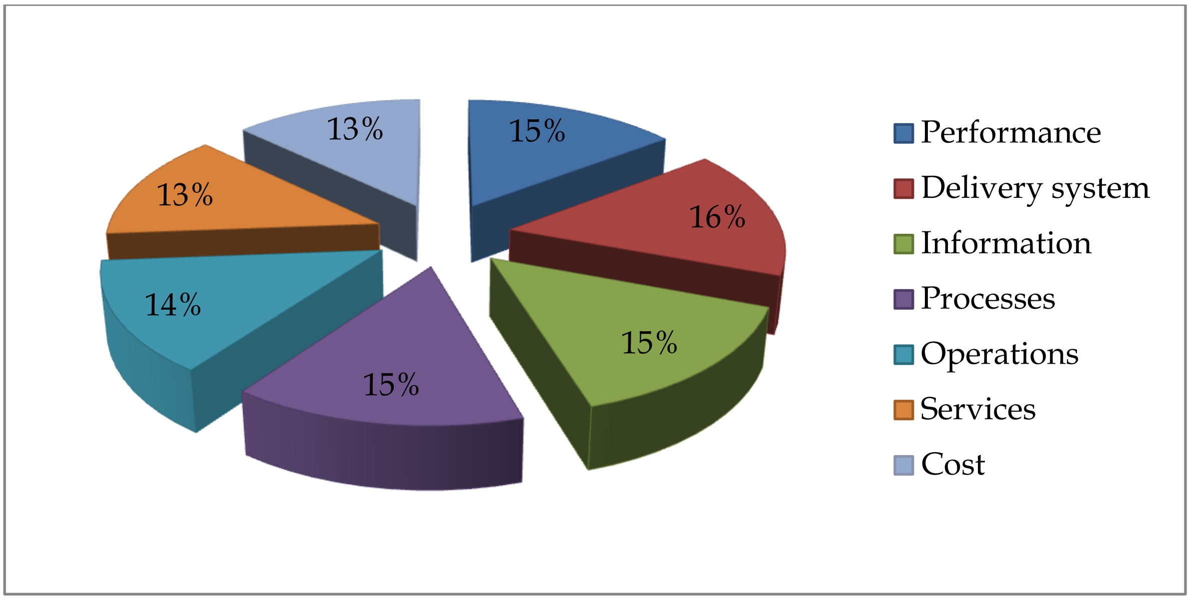


**Fig.2. Attributes for supply chain performance analysis**

Among the attributes, delivery system is the major attribute explained the supple chain performance followed by performance, information and processes involved in the supply chain.

**Techniques used to evaluate the supply chain performance**

Apart from attributes, there are certain techniques which are usually used to evaluate the supply chain. The popular techniques used in the analysis are furnished in the table below.

**Table. 1. Techniques used to evaluate the supply chain**

| Techniques | Utility (%) |
|---|---|
| Structural Equation Models (SEM) | 22 |
| Empirical analysis | 20 |
| Descriptive analysis | 18 |
| Simulation models | 10 |
| Analytical Hierarchical Process (AHP) | 5 |
| Regression Analysis | 2 |
| Discriminate Analysis | 1 |

The popular techniques used in supply chain analysis are structural equation models, empirical analysis, descriptive analysis and simulation models. SEM is a possible technique used to find causal relations among latent variables, where the performance is a dependent latent variable that is measure by using other variables. The second group of techniques is the empirical analysis, related to cases of studies in different sectors and this technique is very important because usually are referred to do comparisons among firms. Another big group of techniques is the descriptive analysis that includes measures related to central tendency and dispersion.

**Methodology used**

The multivariate analysis is the most widely used group of methodologies and the second place was occupied by cases of study. The third place is occupied by reviews. There are others techniques applied for supply chain performance but at lower scale are like quantitative analysis, multi-criteria analysis and six sigma.

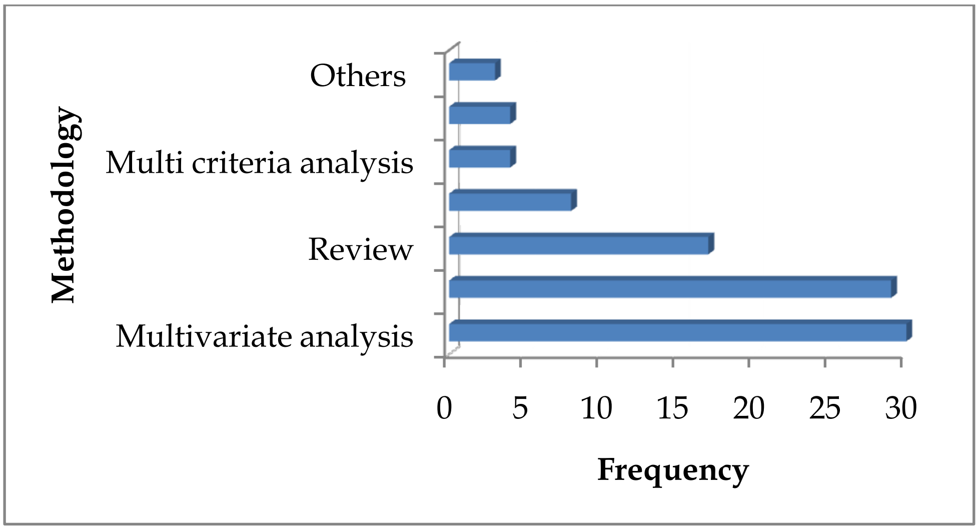



**Fig.3. Methodologies used to assess the supply chain performance**

**Supply chain mapping**

A supply chain map is a representation of process in such a way to facilitate through monitoring of supply chain integration progress. A map will depict the initial status and the proposed structure to be developed and disseminated. This helps to evaluate the progress at various points along the way to the supply chain redesign goal. There are various methodologies used to map the supply chain. Finally, a well-documented supply chain mapping approach can lead to an improved supply chain management procedure. There are certain methods used in supply chain mapping.

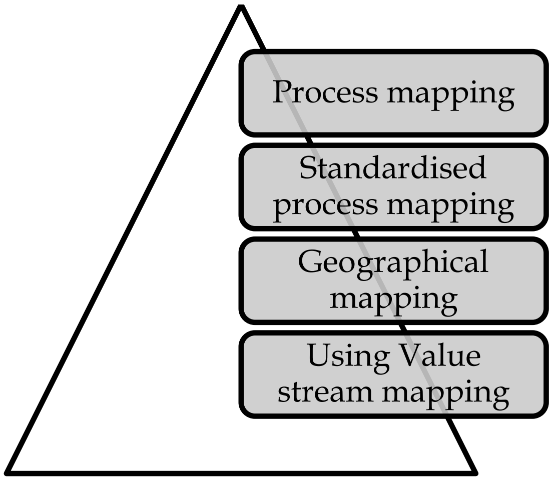



**Fig.4. Methods used in supply chain mapping**

1. **Process mapping:** It aims to cover all the processes involved in deriving the output. It includes input, control, output and mechanism involved in the process. It comprises of the detailed functions or processes involved in the system as a whole. It illustrates that how the existing processed work rather than how the process to be analysed. But, this method requires lot of time and resources.

2. **Standardised process mapping:** It is a method used to identify the standardized processes which can be better applied towards specific processes. This showed the standardized processes only rather than detailed or whole processes.

3. **Geographical supply chain mapping:** Instead of process, this explains how the supply chain network works at different regions or locations. The linkages and co-ordination the network enhance the supply chain performance.

4. **Supply chain mapping using value stream mapping:** The value stream mapping (VSM) involves a system approach rather than a process or network. Value stream mapping is the process of identifying bottlenecks, waste, and value-added steps within a flow of material and information. The value stream map is the appropriately named tool used to present and analyze the information uncovered by looking deeper into an organization’s processes. This is a modern and practical approach used for supply chain mapping. There are different steps involved in VSM that are explained below.

Step I: Selection of product

Step II: Identification of distribution channels

Step III: Location mapping

Step IV: Identification of information flows

Step V: Developing alternatives

**Fig. 5. Steps in value stream mapping approach**

**Supply chain map attributes**

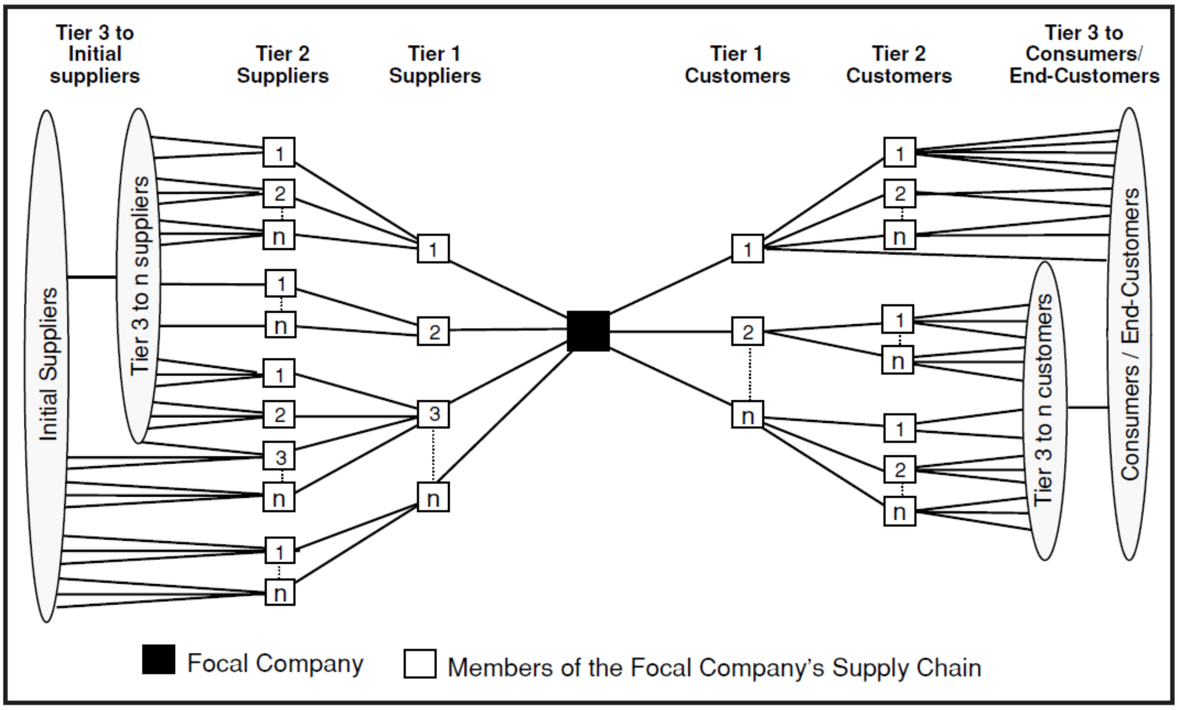
Supply chain mapping is explained by certain attributes viz., geometry, perspectives and implementation issues.

**Table. 2. Attributes used in supply chain mapping**

| **Attributes** | **Meaning** |
|---|---|
| **I. Geometry** | |
| a. Tiers | Number of units performed |
| Direction | Either up or down |
| Length | Number of levels in each direction |
| b. Aggregation | Degree of specificity with in a tier |
| c. Spatial | Geographical representation |
| **II. Perspective** | |
| a. Focal point | Firm-centric or industry-centric |
| b. Scope | Scope perspective |
| Product breadth | Product coverage |
| Supply chain perspective | Key processes in the supply chain |
| Process view depth | Includes complete set of detailed processes |
| Cycle view | Includes distribution channels and feedback loops |
| **III. Implementation issues** | |
| a. Information density | Amount of information integrated |
| b. Live link to database | Linked to preexisting database |
| c. Delivery mode | Mechanism made available to consumers |

The supply chain network structure derived using the attributes of the supply chain mapping is presented below.

SUPPLY CHAIN NETWORK STRUCTURE




Source: Lambert, cooper and Pagh (1998)

**Traditional and Supply chain approach in management**

There are differences between the traditional and supply chain management process. The differences are given in table. 3.

**Table 3. Differences between traditional and supply chain approach in management process**

| **Process** | **Traditional** | **Supply Chain** |
|---|---|---|
| Inventory Management | Only company based approach | Integrated and holistic approach |
| Cost Management | Focused on price (Price focus) | Focused on total cost |
| Coordination | Limited | Extensive planning and planning |
| Planning | None | Integrated with information technology |
| Supplier Management | Not so close with key suppliers | Close relationships with key suppliers |

Fish is highly perishable and inherently unpredictable, which makes the fish supply chain a complicated one. The nature of fishing operations also makes the predictability even more complicated. This is the major challenge faced by the supply chain management of fisheries.

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## Chapter 26

**Livelihood opportunities for fisherwomen through activity clusters – A case study of clam**

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Activity clusters have been long associated with collective action for achieving common goals. This could be employment, income, or for achieving other social-political targets. Under a project funded by the Department of Science & Technology, Government of India, clustering activity was taken up for clam fishers harvesting black clam, *Villoritacyprinoides* at a village in Kerala. Kerala is a state with one of the richest clam resources in India. The main clam species available in Kerala estuaries in the order of abundance are *Villoritacyprinoides, Meretrixcasta, Paphiamalabarica, Katelysiaopima* and *Meretrixmeretrix*.

Clam fishing has been a traditional family oriented activity along the backwaters. The levels of investment are low both for harvesting and processing and both meat and the shell have a market. Though the activity is seasonal and there are periods of good harvest of large sized clams, this activity is carried out almost all through the year. In clam picking, colonies of clam are located in the backwaters and the clam collected, either manually or using a dredge net. Clam meat and shell are the two economically important products of the fishery. The clam meat is mainly consumed locally and a small portion has been utilised as a feed in shrimp farms (Laxmilatha and Appukuttan, 2002). In the whole clam, almost 80% of the weight is the shell and the meat around 10%. It is estimated that around 5000-7000 persons are engaged in clam picking (Appukuttan, 2007) from various water bodies and are engaged in processing and marketing of the shell as well as meat.

Theclam fishers who were targeted for this project and their fishery is located at Perumbalam village which comes under Poochakkalpanchayat of the Thycatusherry block of the Cherthalataluk of Alleppey district in South Kerala. The village is an island and the nearest town Arookutty, which is 4.5kms from the island, borders Ernakulam city. The distance to Ernakulam city is around 19 km. The geographical area of 16.32 $km^2$, it is around 7kms in length and 2 kms in width. This village has about 250 families that carries out clam picking activity. The activity is a family based activity, with the men engaged in harvesting (though it is not exclusively a male activity as women are also involved in picking), the women processing the harvested clam and undertaking the marketing activity. Their detailed daily routine activity such as clam picking and processing actives timeline is given in Fig. 1) (Gopal et. al., 2011; Gopal et. al., 2014).

Fig. 1: Time analysis of fisher persons involved in the clam picking and processing activity

| Market | Timing/ Gender | 4.00 to 6.00 am | 6.00 to 8.00 am | 8.00 to 10.00 am | 10.00 am to 12.00 pm | 12.00 to 2.00 pm | 2.00 to 4.00 pm | 4.00 to 6.00 pm | 2.00 to 4.00 am |
|---|---|---|---|---|---|---|---|---|---|
| Morning Market | Men | Clam Picking | | | | | | | |
| | Women | Clam Processing | Clam Marketing | | | | | | Clam Processing |
| | | | | | | | | | |
| Evening Market | Men | Clam Picking | | | | | | | |
| | Women | | | Clam Processing | | | Clam Marketing | | |

Both men and women were involved in picking clam though men dominated this activity. The total time spent on harvesting can last upto 10 h. The larger sized clams are boiled while the smaller ones are either sold whole to the shell traders or are relaid. The clam fishers were the primary targets of the cluster development activity. The cluster faces uncertainties with regards to their daily catches. Their inconsistent and low incomes in turn adversely affects living conditions, family health and nutrition, as well as children's education. The cluster was not supported by any agency/ Institute explicitly. However the fishers have been using the services of the agencies/Institutions in the village for various purposes.ICAR-CIFT through the project supported the development of the cluster as well as had a long term staretgy of improving the methods of processing of clam, so as to reduce drudgery and improve incomes of the fisherwomen and families.

Cluster meetings

The methodology of ICAR-CIFT for cluster development is given in Fig. 2.

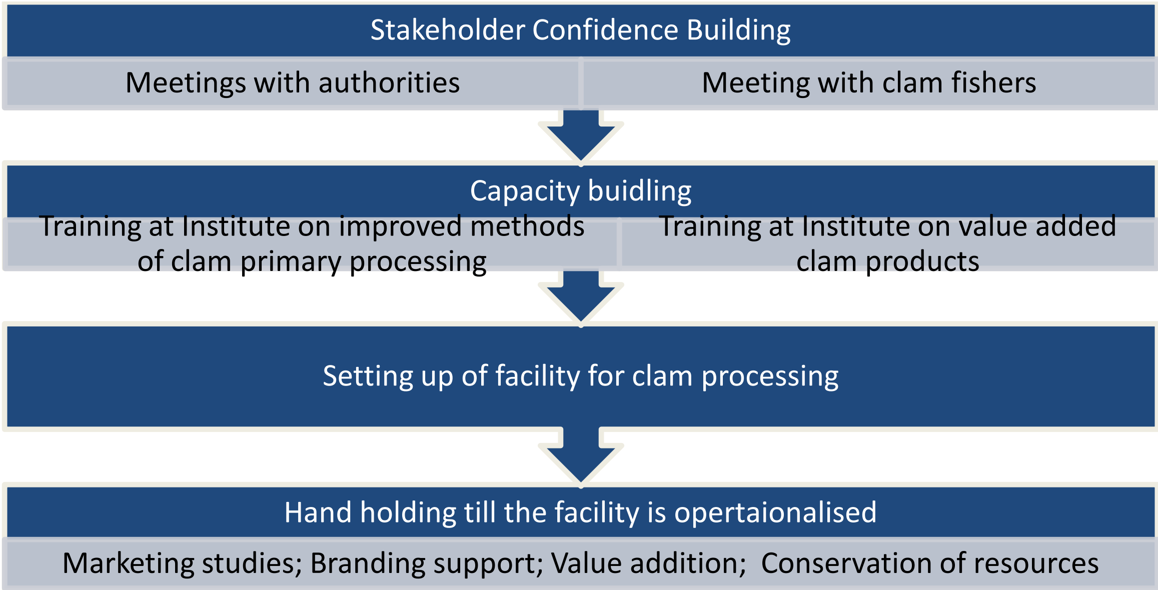
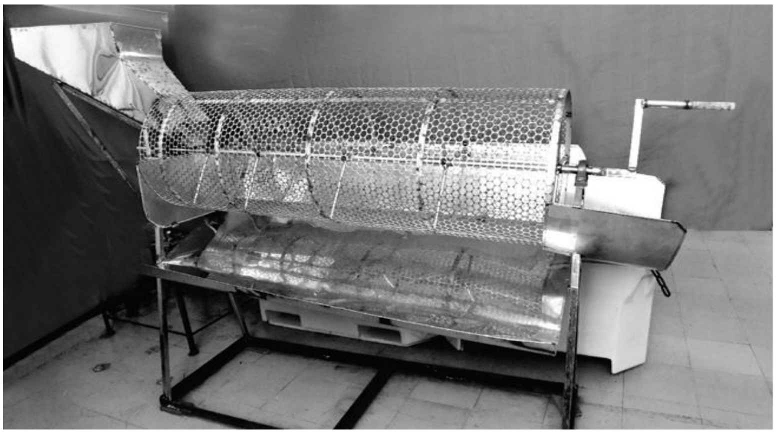



Fig 2: Cluster Development Strategy

The strength of the Institute in value addition helped in strengthening the idea of forming the cluster as the fishers, especially the women, were exposed to the same through targeted capacity building programmes. Simultaneously conservation of the resource by relaying small sized calms that were harvested along with the mature and marketable sizes was encouraged, through relaying activities. The processing facility is being set up for depuration, mechanised boiling and shucking through equipment specifically developed for the purpose (Sreejth et. al., 2018).



Constant interaction with the fishers and reinforcement of the benefits of clustering and collective action are necessary for successful implementation.

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# Chapter 27

## Gender issues in fish entrepreneurship development

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### Gender participation in fishery

As per the reports of FAO 59.6 million People were engaged in the primary sector of capture fisheries and aquaculture in 2016, which include 19.3 million in aquaculture and 40.3 million in capture fisheries. Out of this nearly 14 per cent were women, which is a less proportion as compared to that of 2009–2016 periods (15.2%). Decreased gender-disaggregated reporting is ascribed as the reason for decreasing trend of proportion of women in primary sector fisheries (FAO, 2018). This scenario indicate that fisheries empower women and contribute to gender equity; however, their role has largely been unrecognized (HLPE, 2014). When both the primary and secondary sectors of aquaculture and fisheries were considered, the work force was evenly divided between men and women (Monfort , 2015).

### Gender reporting

Gender-disaggregated data on secondary sector fisheries has not been collected by FAO from Member Countries. Enhanced statistics on both industrial and small scale operators, together with data on the secondary post-harvest and service sectors, would greatly improve the understanding of the importance of women's contribution to fisheries and aquaculture, food security and livelihoods (FAO, 2018). Gender-disaggregated employment data were reported by Japan in 1970, and since then the reporting of sex-disaggregated employment data by FAO Member Countries has been slowly improving in regularity and quality. These data are receiving increasing policy attention and are critical in support to decision-making on gender issues in fisheries and aquaculture (Biswas, 2017).

### Global inland fisheries

The World Bank (2012) indicated that about 35 million of the estimated 60 million people engaged in global inland fisheries and their value chains – about half – are women. However, their role has largely been unrecognized (HLPE, 2014). Women are strongly associated with the post-harvest sector e.g. processing, sales, distribution and marketing; however, women also fish. They obtain income, independence and power through these activities. Income earned by women often has a stronger, more beneficial impact on household incomes (Porter, 2012). In 61 countries that report disaggregated data to FAO and where women are recognized as fishers, the ratio is one fisherwoman to every 7.3 fishermen (Simmance, Funge-Smith and Gee, 2018).

### Indian fishery

India is the second largest producer of fish and fresh water fish in the world. Fish production in India has increased from 41.57 lakh tonnes (24.47 lakh tonnes for marine and 17.10 lakh tones for inland fisheries) in 1991-92 to 107.95 lakh tonnes (35.8 lakh tonnes for marine and 72.10 lakh tonnes for inland fisheries) in 2015-16. The share of fishing and aquaculture in GVA in agriculture has been showing a steady value of 5% from the period 2011-12 to the period 2015-16 (Economic Survey 2017-18 Volume 2).

Fish and fishery products are one of the most widely traded commodities in India. The estimated value of marine fish landings in the country has increased by 8.37% during 2017 over the past year (2016) followed by consequential increases in unit price at fish landing Centre, unit price at retail market, and in the producers share of the consumers' rupee(CMFRI Report)

The fisheries sector is an important source of livelihood for women In India. Among the Indian states Kerala has overtaken to emerge as the third largest in the state-wise marine fish landings in India During 2017. Four maritime states such as Gujarat, Tamil Nadu, Kerala and Karnataka landed more than 5 lakh tonnes accounting for 67% of country's marine fish landings during the year. The fisherwomen in Kerala play an important role in the fisheries sector in terms of their involvement in fishery related activities *viz*., fish vending, fish drying, prawn peeling, sorting, grading, fish packing, and net making. Women are actively involved in the processing of fish catch, such as sun-drying, salting, smoking and preparing fish and fish-derived foods such as fish paste and cakes, either in cottage level industries, or as wage labourers in large scale processing industries.

**Gender concept**

**Gender** refers to the economic, social, political, and cultural attributes and opportunities associated with being women and men. The social definitions of what it means to be a woman or a man vary among cultures and change over time. Gender is a socio-cultural expression of particular characteristics and roles that are associated with certain groups of people with reference to being male or female.

**Gender Analysis** is a methodology that describes existing gender relations in a particular environment, ranging from within households or firms to a larger scale of community, ethnic group, or nation. It involves collecting and analyzing sex-disaggregated data and other qualitative and quantitative information.

**Gender Assessment** examines how a program or project addresses and responds to gender disparities and inequalities through its objectives, activities, and policies. It responds to two key questions. How will the different roles and status of women and men within the community, political sphere, workplace, and household affect the work to be undertaken? How will the anticipated results of the work affect women and men differently? And their relative status?

**Gender Equity** is the process of being fair to women and men. To ensure fairness, measures must be taken to compensate for historical and social disadvantages that prevent women and men from operating on a level playing field.

**Gender Equality** is the state or condition that affords women and men equal enjoyment of human rights, socially valued goods, opportunities, and resources.

**Gender Integration** refers to strategies applied in program assessment, design, implementation, and evaluation to take gender norms into account and to compensate for gender-based inequalities.

**Gender Mainstreaming** is the process of incorporating a gender perspective into policies, strategies, programs, project activities, and administrative functions, as well as into the institutional culture of an organization (https://gender.jhpiego.org/analysistoolkit/gender-concepts-and-definitions/).

**Gender issues in fish entrepreneurship development'**

Women play a significant and crucial role in agricultural development and allied fields including fisheries. But the contributions of women were taken for granted for a long period (NCW, 2001). For sustainable development of the agriculture and rural economy, the contribution of women to agriculture and food production cannot be ignored Economic Survey 2017-18 Volume 2). Recently the trend has changed. Recognizing the critical role of women in agriculture, the Ministry of Agriculture and Farmers Welfare has declared 15th October of every year as Women Farmer's Day. Entrepreneurship development in agrarian sector is regarded as one of the major requirement. Political will is needed to implement and practice gender mainstreaming. Policy makers must be convinced of the need for change, and prerequisites for well-developed policies should be put in place. Such policies must rest on the principles of **Economic empowerment of women** throughout the value chain (FAO,2012).

**Measures taken by GOI, to ensure mainstreaming of women in agriculture sector**

- Earmarking at least 30 per cent of the budget allocation for women beneficiariesin all ongoing schemes/programmes and development activities
- Initiating women centric activities to ensure benefits of various beneficiary-oriented programs/schemes reach them.
- Focusing on women self-help group (SHG) to connect them to micro-credit through capacity building activities and to provide information and ensuring their representation in different decision-making bodies.

**Restructured Centrally Sponsored Scheme**: Integrated Development and Management of Fisheries(Blue Revolution) is with a total Central outlay of **3000 crore for five years** objectives are to generate employment and export earnings and to ensure inclusive development and empower fishers and aquaculture farmers.

**CSS** encompasses inclusive development by providing special care to Fishermen Societies, Cooperative Bodies, Women, Scheduled Castes (SCs) and Scheduled Tribes (STs) and under developed regions etc. by extending adequate financial assistance. Emphasis may also be on promoting investment & entrepreneurship development, arrangements for institutional financing, facilitating backward and forward linkages, training and capacity building etc. 10.2 The States/ UTs shall also accord high priority to the proposals of fishers, fish farmers, fishers cooperatives, SCs/ STs & women and their SHG's, cooperatives, and other weaker segments of the society so as to ensure adequate coverage of such beneficiaries as intended in the scheme

http://www.dahd.nic.in/about-us/divisions/fisheries

**Creation of Fisheries and Aquaculture Infrastructure Development Fund (FIDF)**

Special Fisheries and Aquaculture Infrastructure Development Fund (FIDF). To augment fish production to achieve its target of 15 million tonne by 2020 set under the

Blue Revolution; and to achieve a sustainable growth of 8% -9% thereafter to reach the fish production to the level of about 20 MMT by 2022-23. Employment opportunities to over 9.40 lakh fishers/fishermen/fisherfolk and other entrepreneurs in fishing and allied activities. To attract private investment in creation and management of fisheries infrastructure facilities. Adoption of new technologies. The approval entails an estimated fund size of Rs.**7,522 crore**, comprising Rs.5,266.40 crore to be raised by the Nodal Loaning Entities (NLEs), Rs. 1,316.6 crore beneficiaries contribution and Rs.939.48 crore budgetary support from the Government of India.

FIDF would provide concessional finance to State Governments / UTs and State entities, cooperatives, individuals and entrepreneurs etc., for taking up of the identified investment activities of fisheries development. Under FIDF, loan lending will be over a period of five years from 2018-19 to 2022-23 and maximum repayment will be over a period of 12 years inclusive of moratorium of two years on repayment of principal. State Governments, Cooperatives and individual investors will get loans at cheap rates for fisheries and animal husbandry infrastructure.

**National Fisheries Development Board (NFDB).**

Setting up of Mobile/Retail Fish Outlet (Kiosk), (Kiosk along with one fish storage/ display cabin, one visi cooler, weighing machine, facilities/ utensils for fish cutting cleaning facilities) As per actual with a ceiling of **Rs. 10 lakh per unit**, Fish retail outlet/kiosk shall be of a minimum floor area of 100 Sq.ft (static), Priority shall be given to SCs / STs/ women / unemployed youth.

Under Beneficiary Oriented Projects Funded by DADF, Govt. of India Women & their Cooperatives can avail 60% Govt. Assistance along with 40% Beneficiaries Share. Women and their Co-operatives are one of the implementing agencies.

**Fish based enterprises among women in Kerala**

Value added fish products based enterprises provides better opportunities for women especially to those who are living in coastal areas to earn a livelihood out of it. Though women groups are mobilized and skill enhancement was done through training by various agencies, sustainability of such enterprise is a real challenge faced by women. (Rejula et al 2018).

In a study conducted in Kerala state for analyzing drivers and barriers of sustainability of fish based enterprises ,it was identified that, majority of women possess socio-personal traits which were found in entrepreneurs and the consortium mode of implementation helped in group formation, and implementation of the programme. But at later stage of sustenance consortium mode of operation hindered the natural growth of the enterprise. Even though Govt-Govt consortium proved successful the women involved in this group could not develop their entrepreneurial capacities. Sustainability of enterprise depends on many factors which need to be addressed by technology scientist, social scientist with the help all other stakeholders involved in it

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# Chapter 28

## ICT application in fisheries

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### Introduction

The world is undergoing an Information Communication Technology (ICT) revolution, a revolution that has enormous socio-economic implications for the developed and developing countries.The 'fisheries and aquaculture sector' is recognized as the sunshine sector in Indian agricultureas it provides employment opportunities, nutritional security and foreign exchange earnings through fish export. The ICT has completely changed format of the dissemination of information in to digital with worldwide approach and ICT has become first and foremost need of Fisheries academician, researchers and extension workers. Fisheries researchers bring innovation and the extension worker has to transmit the scientific information to the fish farmers.

### Importance of ICTs in Fisheries

New information and communication technologies (ICTs) are being used across the fisheries sector, from resource assessment, capture or culture to processing and commercialization.

- Global Positioning Systems (GPS) used for navigation and location finding, mobile phones for trading, information exchange and emergencies, radio programming with fishing communities and web-based information and networking resources. (FAO, 2007).
- Mobile phones in India have brought about a tremendous change in fisheries sector. One result was a dramatic improvement in the efficiency and profitability of the fishing industry. As mobile phone service spread, it allowed fishermen to land their catches where there were wholesalers ready to purchase them. This reduced waste from between 5-8 per cent of total catch to close to zero and increased average profitability by around 8 per cent. At the same time, consumer prices fell by 4 per cent.
- The internet is emerging as a tool with potential to contribute to rural development. Internet enables rural communities to receive information and assistance from other development organizations. It also offers opportunities for two-way and horizontal communication and for opening up communication channels for rural communities and developmentorganizations.It can facilitate dialogue among communities and with government planners, development agencies, researchers, and technical experts: encourage community participation in decision-making; coordinating local, regional and national development efforts for increased effectiveness. Help agricultural researchers, technicians, farmers and others in sharing information. Internet can also give a vast global information resource. The Internet has proven valuable for the development of Fisheries in developing countries like India.

## ICT Initiatives in Fisheries Sector

### Agricultural Technology Information Centers (ATIC)

- The establishment of agricultural technology information centers (ATIC) can forge a better interaction between researchers and technology users. ATIC acts as a single window system with an objective to help farmers and other stakeholders to provide solutions to their agriculture related problems. This also helps in providing technological information along with technology inputs and products. Such information is useful for farmers, entrepreneurs, extension workers, NGOs and private sector organizations.

### Agricultural Knowledge Management Unit (AKMU)

- Agricultural Knowledge Management Units (AKMU) in ICAR caters to meet the ITC needs of the institutes by providing and maintaining the Internet, Email, Video Conferencing and other computer related facilities. AKMU also periodically updates Institute Website and Personnel Management Information System Network (PERMISnet) of the employees of the institute. AKMU also supposed to maintain the database of scientific research data generated as output of each research project for knowledge sharing and policy formulation.

### KisanCallCentre

- The Department of Agriculture & Cooperation (DAC), Ministry of Agriculture and Farmers Welfare, Govt. of India launched Kisan Call Centers across the country to deliver extension services to the farming community. A Kisan Call Centers consists of a complex of telecommunication infrastructure, computer support and human resources organized to respond the queries raised by farmers in their local languages. Subject Matter Specialists (SMS) using telephone and computers, interact with farmers directly to understand the problems and answer the queries at the call centers. There are call centers for every state that are expected to handle traffic from any part of the country.

### Helpline

- The helplines address queries related at specific hours. The helpline number is advertised through mass media viz., radio and press.

### Aqua service centers

- These centers offer services like soil and water testing, feed analysis, seed quality testing (PCR test), disease diagnosis and market intelligence. They also sell inputs such as feed, fertilizers, pesticides, other therapeutics etc.

### One Stop Aqua Shop (OAS)

- It is intended that OAS would provide better access to farmers regarding appropriate aquaculture technology as well as information on government schemes and rural banking and micro finance. It was also envisaged that OAS would sell fish seed and other inputs. The shop is a single outlet for all inputs that a farmer may require in the cultivation of fish. The inputs include fish seed, fertilizers, chemicals etc. The OAS is also helping farmers in providing information on fish farming through information brochures

### Aqua Choupal

- Aqua choupal, the unique web based initiative of ITC Ltd. offers the farmers of the state of Andhra Pradesh all the information, products and services they need to enhance productivity improve farm gate prize realization and cut transaction cost. Farmers can access information on weather, scientific farming practices and market prices through a web portal. Aqua choupal also facilitate the supply of high quality farm inputs as well as purchase of shrimps at their doorstep.

**Rural Knowledge Centre**

- Its primary aim is to set up multipurpose resource centers at the villages of the country. Each Knowledge center is run by local self-help groups, and cater to knowledge based livelihoods and create income avenues for rural people, farming communities and disadvantaged people.

**Cyber extension**

- The internet is emerging as a tool with potential to contribute to rural development. Internet enables rural communities to receive information and assistance from other development organisations: offer opportunities for two-way and horizontal communication and for opening up communication channels for rural communities and development organisations.

**Information Systems**

- An information system (IS)is the information and communication technology (ICT) that an organization uses, and also the way in which people interact with this technology in support of business processes.An information system is an organized system for the collection, organization, storage and communication / dissemination of information. More specifically, techniciansor extension workers either develop or use information systems to collect, filter, process, create and distribute informations. Some of the information systems developed by Indian Council of Agricultural Research (ICAR) are listed below

1. KRISHI - https://krishi.icar.gov.in/
2. CaneInfo- http://caneinfo.icar.gov.in//
3. Expert system on Wheat - http://www.iasri.res.in/wheat/
4. CeRA- https://icar.org.in/content/consortium-e-resources-agriculture-cera
5. KVK Portal - https://kvk.icar.gov.in/

- A complete list of knowledge initiative in ICAR is give in the ICAR website (**https://icar.org.in/**) and other knowledge initiatives are available in the URL**https://icar.org.in/content/technologies-and-knowledge-resources**

**Mobile Applications**

- A mobile app or mobile application is a computer program designed to run on a mobile device such as a phone/tablet. Mobile apps provide the information on different technologies to the end user in their fingertips. Interactive mobile apps provide a two way communication between the technologists/ extension workers and end users. Indian Council of Agricultural Research (ICAR) has developed almost 111 mobile applications for the end user to disseminate the knowledge in the agriculture and allied sectors. The list of mobile applications are available in the link https://icar.org.in/mobileapp

**E-Databases**

- The networked information sources- locally informed databases, regional or statewide consortia licensed databases, aggregated databases, publishers databases, public available (web) resources etc. E - databases can be exploited to acquire the information which could facilitate the extension activities.

**E- Journals**

- The e-journal is an electronic form of a journal, serial magazine, newspaper, newsletter, continuing directory, annual report and some monographic series if classed together. A journal-like electronic publication with no print counter port made available via the web is an electronic journal.

**E-Books**

- An e-book is an electronic version of a traditional print book that can be read by using a personal computer or by using an e-book reader. E-books can be useful to acquire rapid information which would be helpful to address the various issues in the culture, harvest and post-harvest fisheries.

**General uses and advantages of e-resources**

There is greater need to transform the agricultural, specifically fisheries sector by taking into account its achievements and capabilities. The strong and sustaining ecological resource base, rational and pre-emptive policy, public and private investments, good governance, etc holds the key for sustainable growth of the sector. The fuller utilization of its potential can be achieved through infrastructure, investments, technology intensification, diversification and value addition. In a nutshell, various issues related to fishing activities in India need to be addressed in a time bound manner with mutual understanding and cooperation between public and private sectors.

**References**


1. https://icar.org.in/

# Country profile of trainees

**Afghanistan**
**Algeria**
**Bangladesh**
**Guatemala**
**Malawi**
**Mauritius**
**Oman**
**Srilanka**
**Sudan**
**Syria**
**Tanzania**
**Tunisia**
**Uganda**
**Zimbabwe**

# FISHERY SECTOR IN AFGHANISTAN

**Ebadullah Sardarzai**

## MAP OF AFGHANISTAN


## Part I Overview and main indicators

*Part I of the Fishery and Aquaculture Country Profile is compiled using the most up-to-date information available from the FAO Country briefs and Statistics programmes at the time of publication. The Country Brief and the FAO Fisheries Statistics provided in Part I may, however, have been prepared at different times, which would explain any inconsistencies.*

### General geographic and economic indicators

| | |
|---|---|
| Area | 652,000 square kilometers |
| Shelf area | None (country is landlocked) |
| Population (2014) | 32 million |
| Urban population as % of total population (2012) | 24 % |
| Literacy rate (2012) | 38.2 % (male 52%; female 24%) |
| GDP at current prices (2012) | US$ 20.4 billion |
| GDP per head (2012) | US$ 680 |
| Growth rate of GDP (2011-2012) | 14.4 % |
| Agricultural GDP as % of total GDP (2012) | 20 % |
| Fisheries as percent of agricultural GDP (2012) | Probably less than one percent |
| Unemployment (2012) | 40 % (estimated) |
| Percent of population below poverty line (2011) | 35.8 % |
| Per capita internal renewable fresh water (2011) | 1620 cubic meters |
| Tax revenue as % of GDP (2012) | 7.5 % |

| | |
|---|---|
| Merchandise trade as % of GDP (2012) | 32 % |
| Merchandise exports | US$ 511 million (2013 estimate) |
| Share of agriculture in merchandise exports | 52 % |
| Exports of fish | No data available |
| Merchandise imports | US$ 7,729 million |
| Share of agricultural products in total imports | 13.8 % |
| Imports of fish and fish products | No data available |
| Consumption of fish | No data available |
| Sources:<br>The World Bank, 2014 World Development Indicators, pages 12, 30, 46, 60, 74, 88.<br>IMF: Global Finance (Afghanistan GDP and Economic Data), December 7, 2015<br>WTO: Afghanistan Trade, 2015<br>UNESCO: for literacy | |

*Value converted by FAO as per UN currency exchange rate
**Per capita calculated by FAO and converted as per UN currency exchange rate

| | | Source |
|---|---|---|
| Country area | 652 860km$^2$ | FAOSTAT. 2013 |
| Land area | 652 860km$^2$ | FAOSTAT. 2013 |
| Inland water area | 0km$^2$ | Computed. 2013 |
| Population - Est. & Proj. | 39.985millions | FAOSTAT. 2018 |
| GDP (current US$) | 20 815millions | World Bank. 2017 |
| GDP per capita (current US$) | 585.85US$ | World Bank. 2017 |
| Agriculture, forestry, and fishing, value added | 20.97% of GDP | World Bank. 2016 |

FAO Fisheries statistics

**Part II Narrative**

Part II of the Fishery and Aquaculture Country Profile provides supplementary information that is based on national and other sources and that is valid at the time of compilation (see update year above). References to these sources are provided as far as possible.

Afghanistan is a landlocked country, which covers an area of 652,225 km$^2$, nearly 75% of which is mountainous. The average elevation is 1300 m. The climate varies sharply between highlands and lowlands. It is sub-polar in the mountainous northeast with dry, cold winters, with temperatures falling to -26$^o$C or lower in the Hindu Kush range. South of the highlands lies an arid, virtually uninhabited southwestern plateau. There are three great river basins: the Amu-Darya (Oxus), which forms the boundary with Tajikistan, Uzbekistan and Turkmenistan in the north; the Kabul in the northeast, which enters Pakistan in the east where it has a confluence with the Indus; and the Helmand in the southwest, which ends in Iran in a desert lake immediately after crossing the border in the southwest. The source of surface water in all rivers is precipitation, and consequent snow melt, over the central mountain ranges extending from the Pamir mountain knot at the western termination of the Karakoram, the Hindu Kush and its outliers, and the ranges of Hazarajat (Fig. 2). For the net of Afghanistan rivers see Fig. 3.

The following information leans heavily on the publication of Coad (1981), who briefly reviewed the hydrograph in his introduction to the check-list of fishes of Afghanistan.

Maximum water flow is in the spring and early summer and minimum flow is in late summer to winter over much of the country. Many rivers dry up along sections of their course or are reduced to isolated pools during the minimum-flow period. This natural condition is aggravated by water abstraction for irrigation and other purposes,, and rivers tend to disappear before reaching their principal river or lake (Coad, 1981). In the Pamir and Nurestan areas of the northeast, melting glaciers feed the rivers in July and August, but with the advancing freezing temperatures the flow rate greatly diminishes. Rivers along the northeast border with Pakistan are affected by the monsoon and have maximum flows twice a year: July to September and January to April. There are few freshwater lakes in Afghanistan, the largest being those of Sistan which lie mostly in Iran but are hydrographically part of Afghanistan. Major perennial rivers are the Amu Darya, Qonduz (=Kunduz), Kowcheh (=Kokcha), Band-e Amir, Kabul, Lowgar (=Logar), Panjsher, Laghman, Konar (=Kunar), Sorkh Ab, Helmand, Arghandab, Hari Rud and Morghab (=Murgab). The following notes deal only with the major rivers and their major tributaries. Their names, and the names of smaller rivers not mentioned here, but recorded in Fig. 3, will also appear where appropriate in Table 1, which lists the individual fish species and their occurrence.

The Amu Darya River has its sources in the Pamirs, and it ends in the Aral Sea. The lower 1300 km of a total of 2500 km lies wholly outside Afghanistan. Coad included in his list of fish species those which occur in the lower Amu Darya as they may penetrate upriver either naturally or by being stocked there. He did not include fish of the Zarafshan River and its tributaries Kara Darya and Ak Darya, although Zarafshan is now connected with Amu Darya through canals. In its upper reaches the Amu Darya is known as Vakhan River (Vakhsh), then as Panj River (Pyandzh), when it receives the Pamir River. In Afghanistan the Panj is called the Amu Darya when it is joined by the Kowkcheh (=Kokcha) River. However, in Tajikistan, the name of Amu Darya starts from the entry of the Vakhsh. The Qonduz River enters the Amu Darya near its junction with the Vakhsh River.

The Murgab River (or Morghab) has its source in the western Hindu Kush, flowing west and then north to the Afghanistan-Turkmenistan border, crossing into Turkmenistan, where it is lost in the sands of the Kara Kum Desert.

The Hari Rud River, which starts in the centre of Afghanistan, flows directly west and eventually enters Turkmenistan where it is called Tedzhen. It also ends in the sands of the Kara Kum Desert.

The Helmand River has its source not far away from the source of the Kabul River. It flows southwest for about 1300 km before it empties into the Sistan lakes. The river with its tributaries drains about 40% of Afghanistan and has the largest drainage basin. Only the Helmand River is perennial. It has been dammed in several places.

The Kabul River has its source in the mountains west of Kabul and flows east to join the Indus River north of Attock. The river is dammed in several places. It receives a number of tributaries, such as the Panjsher, Laghman, Konar, Lowgar and Sorkh Rud. The Swat and Khiali rivers enter the Kabul River in Pakistan.

**FISHES OF AFGHANISTAN**

The list of fishes as given in Table 1 is an abbreviated version of a more detailed account of fish of Afghanistan by Coad (1981). Species marked * have not been reported from Afghanistan but occur in adjacent or contiguous drainage basins. Species marked # have been introduced into Afghanistan. The species *Pungitius platygaster* was left out from the list as it occurs only in the Aral Sea and Amu Darya delta.

**CAPTURE FISHERIES AND AQUACULTURE**

Fisheries activities in rivers and streams of Afghanistan have been very limited, and information on the number of fishermen, fish species captured, yields and total catch does not exist. The FAO Yearbook on Fishery Statistics has been publishing estimates of catches, rising from 800 t in 1986 to 1300 t in 1995 (FAO, 1997) as compared to the estimate of 100 t for 1963 (El Zarka, 1973). The true situation may be considerably different from these estimates, as no concrete data have been submitted by Afghanistan for at least the last 10 years. It is recognised that fish does not contribute much to the economy of the country and therefore is not paid the same attention as other animal resources.

In 1967 a trout fish hatchery was established at Qargha Dam, about 15 km from Kabul. The dam, constructed across the River Paghman, created a water reservoir of about 50 $km^2$. The hatchery was supplied with water from this reservoir. In the 1970s it was producing about 30,000 trout fingerlings, which were stocked into the Qargha Reservoir and the rivers Panjsher, Bamian, Salang and Sarde (El Zarka, 1973). The stocking of the reservoir was done largely for licensed sport fishing. In the 1970s a second trout hatchery was located near the town of Paghman, west of Kabul.

In 1987, assistance was provided by the UNDP/FAO to rehabilitate the Qargha Fish Farm near Kabul. During 1988-89 supplies of spring water were restored, egg incubators repaired and fitted with new egg trays, and the hatchery brought back into production. The intention was to produce fish to market size in floating cages moored in the adjacent Qargha Reservoir. Concrete raceways next to the farm were also brought back into usable condition. Rainbow trout were grown from eyed eggs imported from Denmark in 1988, and by 1989 six tons of fingerlings were produced. The deteriorating security situation in 1989 interfered with a successful completion of the project, with much of the trout production being stolen or sold underweight. Only 3 tons were sold, against a target of 10 tons. Nevertheless, the project demonstrated the technical feasibility of culturing rainbow trout at Qargha fish farm (FAO, 1990).

At the same time a warmwater fish farm was located alongside Darunta, 150 km east of Kabul. This hatchery was completed in 1966 with the assistance of China, and China also provided technical assistance until 1972. Darunta fish farm was producing fingerlings of four carp species (grass, silver, common, and bighead). The fingerlings were stocked into Darunta Reservoir, and resulted in the production of 144.2 t of fish over the period of 1967-1973, with 30 t captured in 1973 (El Zarka). At that time there were 41 fishermen harvesting the reservoir fish. Management of fish stocks in the reservoir faced several problems, such as escape of fish during floods over the flood controlling gates, and the presence of dense aquatic vegetation. By 1973 a decline in catches was also observed. Nevertheless, it was believed that reservoirs would be important for the future development of inland fisheries. At that time, apart from Darunta, four other reservoirs were situated in not too great a distance from Kabul: Neghlo, Soroby, Arghandab and Kajaki. Kajaki Reservoir was considered to have more favourable conditions for fish production than Arghandab Reservoir, which was considered too oligotrophic, and also subject to drastic drawdown. In 1992 Darunta Dam was seriously damaged in the war.

Production sector: As a landlocked country, Afghanistan is deprived of marine fisheries. The sources for fish are rivers and lakes and most recently the development of a limited number of fish farms with more than 100 species of fish are believed to be native to Afghanistan. These are both cold and warm water species.Total annual fish production is estimated to be about 2,000 metric tons, equally divided between capture fish from rivers and lakes and commercial fish farms.
Aquaculture sub-sector: It is estimated that 300 small fish farms are operational in the entire country but there is no reliable data on how much fish is produced by these farms. Fish eggs are provided to the existing farms from the old hatchery in the Qargha reservoir near Kabul and the new hatchery in Jalalabad assisted by USAID. The hatchery in Jalalabad produces carp seed for sale to local fish farmers. Production in 2011 was estimated at close to 850,000 hatchlings which were stocked into nursery ponds. USAID also provided technical assistance to improve the methods and techniques for the spawning process. Seventy thousand fingerlings from the hatchery were sold to fish farmers in the eastern provinces of Nangarhar and Laghman in 2011.

Post-harvest sector:

Fish utilization Fish remains a very minor part of the Afghan diet. Commercial fishing in the country does not produce enough fish on a sustainable basis to meet local demand.

In rural areas fishing is for family subsistence. Electrification via generators and the use of explosives is used to capture fish from rivers. Although this method of catching is illegal, it’s monitoring by public authorities on how and where to fish is not enforced.

Very little fish is marketed, except in the spring months when the rivers contain enough fish. As rivers recede in the summer months, the available fish declines to a minimum level. Urban populations mostly, if not entirely, depend on imported fresh and frozen fish and shrimps and smoked fish. These products are imported from Pakistan, Iran, UAE, Norway, UK and other European countries. It is speculated that Afghanistan imports about 4,000 tons of fish and fish products annually.

Trends, issues and development Constraints and opportunities There is no written information available on the following features of fisheries in Afghanistan and therefore nothing meaningful could be written in this brief. These features include:

•The role of fisheries in the economy (probably negligible)
•Policy development in the fishery sector
•Investment in fisheries (public or private)
•Research and extension in fisheries
•Fish utilization (post-harvest)
•Institutional arrangement in the fishery sector
•Foreign assistance in fisheries

Fisheries Potential

The FAO Country Programming Framework (CPF) 2012-2015 makes the following statement about the potential of fisheries in Afghanistan.

"As a land-locked country with seasonable water flows and diversion of water for irrigation purposes, fisheries are not a large contribution to the economy, although from a biodiversity perspective, fisheries may be considered in the context of water use and water withdrawals. Afghanistan have minimal aquaculture feasibility but with changing economic conditions there are some aquaculture operations slowly developing as niche markets around large towns and among the northern border where water supplies are more regular, noting that cold water environments may offer reasonable potential for cold water, high value species" (page 16). The CPF does not include any FAO initiative for fisheries in Afghanistan.

However, Afghanistan has adequate water reserves and suitable climate for fish farming (both cold and warm species). The construction of medium size and small dams on a number of rivers also provides opportunities for fish stocking. Areas that have reasonable potential for fish production (including aquaculture) are:

•Perennial rivers in northeast Afghanistan (Amu Draya, Kokcha, Balkh, Kunduz and Murghab Rivers) for cold water species.

•Perennial rivers in eastern Afghanistan (Laghman, Kunar, Pech and Panjshir Rivers) for cold and warm species.

•Perennial rivers in southern Afghanistan (Helmand and Arghandab Rivers) for warm species.

•The Hamoun wetland for warm species. Hamoun is an inland water delta created by spring floods from the Helmand River. The Hamoun is shared by Afghanistan and Iran. Its waters is said to contain nearly 140 species of fish and receives a variety of migrating birds. Once a fertile land, the productivity of this wetland of approximately 2,000 square kilometers has deteriorated severely due to mismanagement. The fisheries in the Hamoun wetland can be rehabilitated through a shared effort by the two countries, including mitigating measures in years of drought.

Investment for fish production in these areas can only be undertaken on the basis appropriate feasibility studies for each potential river basin.

Conclusion A serious study is needed to assess the potential of inland fish production (both capture and culture fish) in Afghanistan and to explore the means by which the potential can be exploited.

Government and non-government sector policies and development strategies

Now Afghanistan currently has a significant fishery sector and lacks a coherent policy for the development of the fisheries sector.

Suggestion and Recommendation

The agricultural policy of the Government of Afghanistan can be summarized as follows:

- Make sustainable agriculture as a major pillar of national economic development and increase the level of investment in agriculture;
- Improve the governance of the agricultural sector and the rural economy;
- Taking realistic measures to mitigate climate shocks;
- Strengthening the linkage between crop and livestock sector;
- Increasing the efficiency of water use in agriculture;
- Accelerating the spread of improved varieties of cultivars;
- Upgrading animal health and husbandry and developing a robust animal feed industry;
- Providing affordable energy to rural areas;
- Strengthening the cooperative system as a major leverage for promoting sustainable agriculture.

Suggestion to India government

On behalf of our country, I thank from India and Keral resident, India government, Foreign Minister, India embassy in Afghanistan, ITEC program, ICAR and CIFT institute all staffs,

In the end of I suggestion to India government to work our country closely in different sector Agriculture, Livestock, Veterinary, Poultry, Fisher, Irrigation and Capacity Building

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# FISHERY SECTOR IN ALGERIA

**Ahmed Bouhamar& Djamal Youcef Achira**

There are 20 major fishing ports along the 1 280 km coastline of Algeria. The continental shelf is approximately of 13 700 km$^2$ and the fishing zone is of about 95 000 km. In 2013 the total of recorded vessels operating from these ports was estimated at 4 569 from which 526 were trawls and 1 231 purse seiners.

Marine capture production is stable between 100 000 and 105 000 tonnes since 2011. Bulk of the catches are small pelagic species. No inland catches are reported.

Aquaculture production is still marginal with the production of 2 200 tonnes in 2013, consisting 1 560 tonnes of carps grown in freshwater, 350 tonnes of gilthead seabream from brackishwater and a very small amount of mussels and oysters. Most of the harvest is sold fresh in local markets. Currently, Algeria is teaming up with an Asian country in an effort to develop marine shrimp seed production and grow-out culture in the country.

Exports of fish and fishery products are rather limited and decreased by 57 percent in the period 2008–2013, due to declining catches. However, in 2014, they increased by 22 percent, reaching USD 7.0 million. During the period 2008-2014, Algeria's imports of fish and fishery products increased by 336 percent, reaching USD 136.1 million in 2014. The annual consumption *per capita* is rather low, at an estimated 3.9 kg in 2012.

In Algeria, the fisheries sector provided 43 700 jobs in 2013. Fisheries and aquaculture development are under the responsibility of the Ministry for fisheries and aquatic resources that was created in 2000 to support fisheries development as a potential livelihood sector. Since 2001, Algeria has enacted a legislation on fisheries and aquaculture. It has recently modernised its National Center for Fisheries and Aquaculture Research and Development (2008).

In general, the fishery resources are not fully exploited. Possibilities exist in particular for the development of artisanal fisheries, especially on the rocky bottoms and of small pelagic fisheries. The fishery industry requires an important effort of modernization and investments, notably for the rehabilitation of the aging fleet (average age of the boats: 20 years) and of the processing facilities.

Aquaculture development has been identified as a strategic priority by the Government which has recently launched an ambitious development programme aiming to create 10 000 direct jobs in the sector in the next five years, and up to 50 000 indirect ones by 2025, by putting 100 000 hectares under cultivation for a target production of 30 000 tonnes per year for export and domestic consumption. Particular emphasis has been given to the development of aquaculture in the desert and arid lands of the country. The main issues affecting aquaculture development are related to: feed availability; limited aquaculture experience by scientists and farmers; production and distribution of seed, and for freshwater aquaculture, high water temperature especially during summer months.

Algeria has been Party to the 1982 UN Convention of the Law of the Sea since 11 June 1996.

# FISHERY SECTOR IN BANGLADESH

Md abdul motin
Shahid shekh md arshad bin

Bangladesh, officially the People's Republic of Bangladesh is a country in South Asia with an area of around 1,47,570 km2. It shares land borders with India and Myanmar (Burma).The country's maritime territory in the Bay of Bengal is roughly equal to the size of its land area. Most of Bangladesh is covered by the Bengal Delta, the largest delta on Earth. The country has 700 rivers and 8,046 km (5,000 mi) of inland waterways. Highlands with evergreen forests are found in the northeastern and southeastern regions of the country. Bangladesh has many islands and a coral reef. The longest unbroken sea beach of the world, Cox's Bazar Beach, is located in the southeast. It is home to the Sundarbans, the largest mangrove forest in the world. The country's biodiversity includes a vast array of plant and wildlife.

Bangladesh is a middle power and a developing nation.It is the world's eighth most populous country. Dhaka is its capital and largest city, followed by Chittagong, which has the country's largest port. Bangladesh forms the largest and easternmost part of the Bengal region. Bangladeshis include people from a range of ethnic groups and religions.It is one of the largest textile/Garments, fish and fishery products, Jute, tea exporters in the world.

## Scenario of Fisheries Sector of Bangladesh

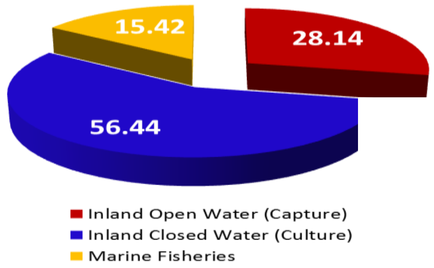
Bangladesh is one of the largest fish producing country of the world. It has a vast area of fresh and marine waterbody. It comprises total inland open water (Capture) areas approximately 39,27,142 ha. andinland closed water (Culture) areas approximately 47,26,320 ha. On the other hand, it has total 710 km long coastal area along with 1,18,813km$^2$ maritime water. Approximately 11% of total population directly or indirectly is involved in fisheries sector.

The contribution of fisheries sector to National GDP is 3.61% and to the agricultural GDP 24.41% (BER-2017). More than 60% of protein demand is fulfilled by this sector.

Bangladesh is well enriched in Fish biodiversity. There are about 260 freshwater fish, 12 exotic fish, 486 marine fish, 24 freshwater shrimp and 36 marine shrimp species available. For Inland aquaculture there are 35 potential fish species including all 12 exotic species like Major carps, Pangas, catfishes, Tilapia, Perch etc.

Present development of fisheries technology and the gradual expansion of this technology in the field level results in huge increase of cultured fish production in Bangladesh. At present every second table fishes come from cultured sector.

Bangladesh declared as a self-sufficient country in fish production. Total fish production in FY 2016-17 was 41.34 MT. Aquaculture production contributes 56.44% to total fish production. In last 30 years the production of total fish has been increased almost five times. Hilsha (Ilish) plays an important role as it is regarded as national fish of



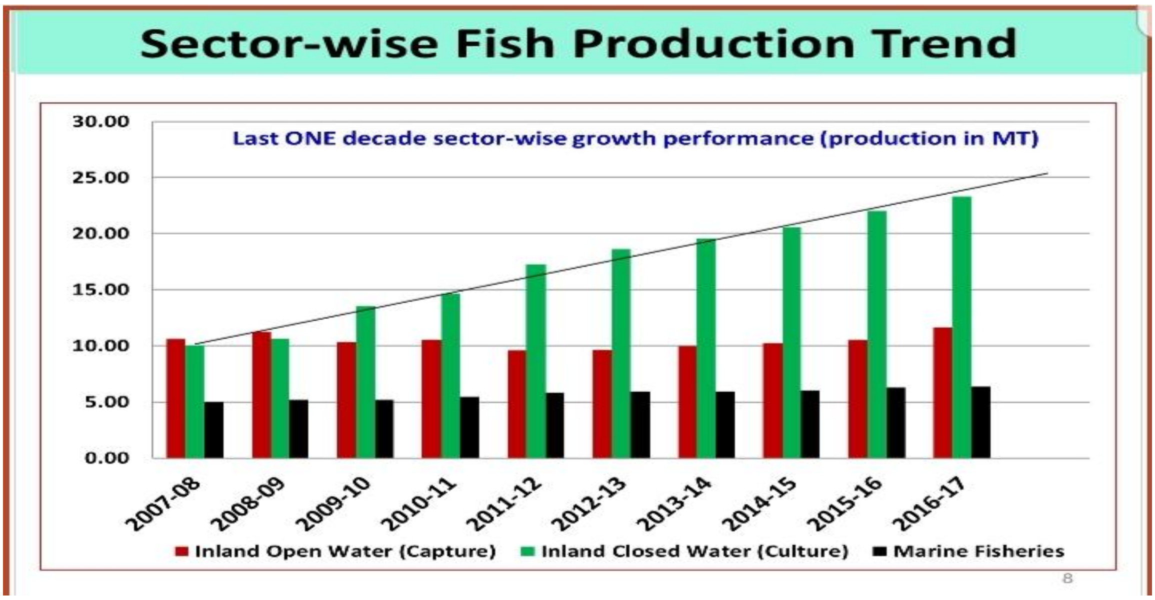

FY: 2016-17

% of production in different

B

Bangladesh and it has great demand all overthe country as well as in abroad also. In last 15 years its production also increased almost two times and this is happened only for development and amendment of different fish conservation laws as well as its enforcement and implementation by proper Govt. authority.

To assure quality product and to export this fish and fishery products Department




of Fisheries (DoF), BD undertook different programs: Farm to fork approack, HACCP along the value chain, National Residue Control plan (NRCP) operation, Traceability system development, Seed and Feed quality monitoring as well as control of aquacultural medicinal products.Fish and fishery products are regarded as second exporting commodities of Bangladesh. Bangladesh Govt. has long visionary plan to improve this sector by proper utilization and management of inland and marine waterbodies.

# FISHERY SECTOR IN GUATEMALA

Alejandro josue joachin Gonzalez

In Guatemala the competent authority for fisheries is the Ministry of Agriculture, livestock and food through the General direction of fisheries and aquaculture, the current legislation is the General of fishing and aquaculture 80-2002. The general law states that hydrobiological resources in the sea, inland waters, exclusive economic zone are public domain, The State exercises the powers of domination over them, determining the right to fish them, administering them and ensuring their rational use.

**Commercialfishingclasification:**

- Artisanal
- Small scale
- Medium scale
- Largescale
- Tuna
- Sport fishing

Artisanal and small-scale commercial fishing is reserved exclusively for Guatemalans, the commercial fishing of medium-scale, large scale and of tuna will be able to be exerted by Guatemalans or foreigners, Subsistence fishing can only be carried out by Guatemalans and will not affect any payment for the right of access to it.

The fisheries in Guatemala are divided into three main groups:

**Fishing in the Pacific Ocean:** in the Pacific Ocean the main fisheries are coastal and deep water shrimps, prawns and lobster, demersal, small pelagic, shark, golden fish and industrial tuna fishery.

On the most important commercial fishery is the Penaide shrimp, which can be done in continental shelfs less than 150 m (deep), for this fishery gillnet is allowed for small scale fishery and trawl net is allowed for medium and large scale, turtle excluder device is mandatory for last two fisheries.

Deep water shrimps catch in the Pacific are *Solenoceraflorea, Solenocera mutator, SolenoceraAgassiz, Heterocarpusvicarious* and *Heterocarpusaffinis.*Prawn *Pleuroncodesplanipes*, catch at more than 150 m (deep), fishing gear is also trawl net.

Others special of high commercial value are Golden Fish *Coryphaenahippurus*and sharks (Alopiidae, Carcharhinidae, Lamnidae, Triakidae, Sphyridae and Ginglymostomatidae, all these species are to be catch at no less thatn 20 nautical miles. Longline is allowed with no more than 1 per boat and no more than 2000 hokes.

Demersal fishes catch in this ocean are: Ariidae, Scianidae, Haemulidae, Lutjanidae, Serranidae.

Pelagic Fishes catch in tis ocean are: Carangidae, Clupeidae, Engraulidae, Scombridae, Pristigasteridae. For artisanal fishery pole and line is allowed, gill net and cost net as well, for small, medium and large-scale trawl, long line, gill net and purse seine are allowed.

Tuna Fishery is practiced exclusively in Pacific Ocean and is the only industial fishery in the country, the species catch are: *Thunnusalbacares, Katsuwonuspelamis,* *Thunnusmaccoyii, Thunnusalalunga, Thunnusobesus, Euthynnuslineatus, Thunnusthynnus, Sardachiliensis*and *Sardachiliensis.*

**Fishing in the Atlantic Ocean:** In the Atlantic Ocean waters only artisanal and small-scale fisheries are allowed and practiced, in this region are catch crustaceans such as Palinuridae, Penaidae and Portunidae; mollusk such as Arcidae, Loliginidae, Strombidae, Melongenidae and Fishes such as Ariidae,Carangidae,Carcharinidae,Batoidea,Centropomidae,Ciclidae,Clupeidae,Engraulidae,Lutjanidae,Megalopidae,Mugilidae,Haemulidae,Sciaenidae,Scombridae,Serranidae,Sphyrnidae.The fishing gears in this area are long line, tramps, gill net

The Atlantic Ocean fishing zone is divided in 3 areas, fishermen must alternate each week.

**Inland fishing:** Inland fisheries are reserved exclusively for subsistence fishing, artisanal fishing and small-scale fishing. The species catch are *D. latifrons, Oreochromis sp, Cichlasomatrimaculatum, Astatherosmacracanthus, Parachromissp, Centropomus robalito, Atractosteustropicus, etc.*

Fishing gears allowed are long line, gill net, cost net and line and pole.

# FISHERY SECTOR IN MALAWI

Charles bernard makuya
Allan katola

The fisheries in Malawi are multi-species and multi-gear (involving a number of exploitation methods in capturing various fish species). Malawi has fresh water lakes, rivers and lagoons from which fishing and fish farming is taking place. Lake Malawi takes up about a third of Malawi's area. and is the fourth largest fresh water lake in the world, by volume, the ninth largest lake in the world by surface area (29,604 $km^2$) and the third largest and second deepest lake in Africa, Lake Malawi is home to more species of fish than any other lake, including at least 800 species of cichlids.

Figure 1 below show the map of Malawi


Thefisheries sector is divided into the artisanal or traditional fisheries and commercial fisheries. On average, the artisanal fisheries contribute about 90 percent of the total fish landings while the commercial fisheries contribute about 10 percent of the total fish landings.

**The artisanal fisheries**

Artisanal fisheries are open access, highly complex, scattered in all water bodies and mainly operate between 0-20 m in Lake Malawi, and cover all possible depth ranges in other water bodies. The artisanal fisheries comprises of a wide range of fishing units, ranging from traditional fishing gears and crafts, such as fish traps and handlines operated from dugout canoes to relatively modern gears and craft, like the seine nets operated from planked boats powered by outboard engines, and employ a number of crew.

Artisanal fisheries target Chambo (*Oreochromis* species), Kambuzi (*Haplochromis*spp.), Usipa (*Engraulicyprissardella*), Utaka (*Copadichromisspp.*), *Kampango* (*Bargrusmeridionalis*) and *Mlamba* (*Clariasgariepinus*). Main fishing gears employed are gillnets, *chambo* seine nets, *kambuzi* seine nets, *nkacha* seine nets, *chilimira* seine nets, longlines, handlines cast nets, and fish traps.

**Status of Fisheries Sector**

The national catch statistics from all water bodies show that total fish production was 199,454 metric tonnes in 2017. Lake Malawi alone registered a total landing of 188,345 metric tonnes, when artisanal and commercial production figures are added (185,096 and 3,249 metric tonnes, respectively). The catches have decreased compared to a decade ago. Some species have gone vanished. The reduction is mainly attributed to the reduced water levels that affect fish recruitment and breeding, overfishing of some fish stocks.

Commercial fisheries highly mechanized, capital intensive and use mainly trawling or purse seining ('ring net') and are restricted to the southern part of Lake Malawi. The fishery consists of pair trawlers units (wooden boats about 8 m long with a 20-40 hp inboard engine), stern trawler (90-385 hp) units and ring nets which are confined to the southern part of the lake. In total there are thirty seven (37) commercial fishing vessels. Pair trawlers fish in waters between 18 m and 50 m and the stern trawlers are restricted in waters above 50 m deep.

**Ornamental Fish Exports**

Lake Malawi has over 800 endemic fish species, which are of both local and international scholarly importance and act as a tourist attraction. Some fish species are exported outside the country for ornamental purpose and this helps bring in foreign exchange. In 2017 there were exports of live fish to nine countries (Canada, Hongkong, China, Denmark, France, Germany, Japan, South Africa, Sweden, Thailand, UK and USA. The largest market for aquarium trade in 2017 was Germany, which imported fish of a value of USD 94, 288.

**Fish Resource Monitoring and Licensing**

To increase fisheries and aquaculture investments, the sector continued to promote fishing related activities through Public Private Partnership (PPP) arrangements. In this regard, a total of 32 large scale commercial fishing units have been licensed to tap offshore deep water fish resources. In addition, more than 503 small scale fishing licenses.

**Performance of Aquaculture Sector**

The country has a total of 15,465 fish farmers, of which 61.51 percent are males and 38.49 percent are females. There are 10,007ponds under fish farming, with a total pond area of 251.59 hectares. Currently there is only one company MALDECO Aquaculture Ltd, a subsidiary of the Press Group of Companies operating under the Foods Company Ltd that is operating cage culture on the lake. It is a large scale industrial operation started in 2003 and have been making progress over the years. Current fish production as of 2017 was over 400 tonnes.

At present the species that are being cultured are, *Tilapia rendalli* (chilunguni), *Oreochromisshiranus*(makumba), *Oreochromismossambicas*(mphende), *Oreochromiskarongae* (chambo) and *Clariasgariepinus* (mlamba).

**Employment**

The Fisheries sector is composed of capture fisheries, aquaculture, and aquarium trade sub-sectors. The sector continues to be a major source of employment. The Fisheries sector directly employs 63,023 as fishers and the sector continues to indirectly employ over half a million people who are engaged in ancillary activities, such as fish processing, fish marketing, boat building and engine repair. The fish industry supports over 1.6 million people and makes a substantial contribution to their livelihoods.

**Food, Nutrition Security and Income source**

The Fisheries sector plays an important role in food and nutrition security. With a production of 199,454 metric tonnes, fish continues to be the main source of animal protein in the country. It contributes over 70 percent of the dietary animal protein intake of Malawians and 40 percent of the total protein supply. In 2017, fish landings had a beach or landed value of MWK173.04 billion (USD235.74 million), with a volume of 199,454 metric tonnes.

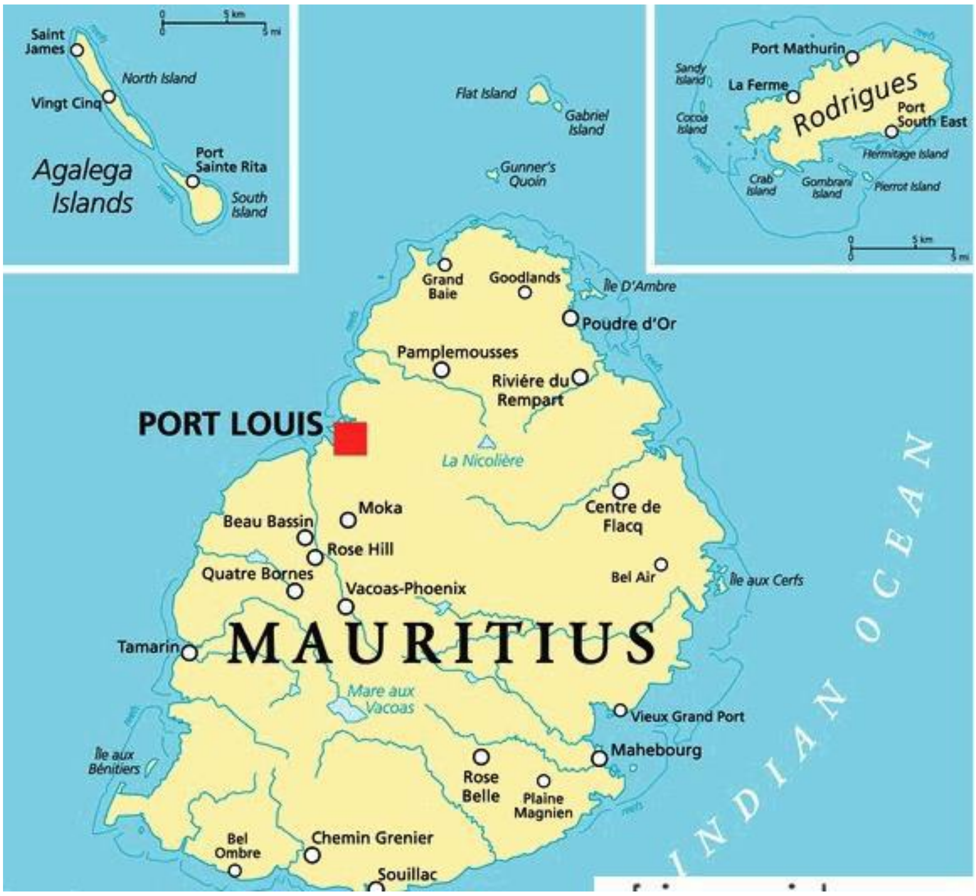
**Challenges**

- Inadequate support of infrastructure for fish landing, processing and marketing along the fish value chain
- Insufficient number of technical and support staff to implement the planned programs
- Climate change leading to poor distribution and amount of rainfall. This affects water availability and levels in ponds and reduces breeding grounds for fish, thereby affecting fish recruitment
- Unavailability of quality fish feeds for faster growth of fish in cages and ponds
- Limited participation of private sector investment in aquaculture

# FISHERY SECTOR IN MAURITIUS

Gajendra Geeane and Pushpa Priyadarshini Seepaul Choolhunpushpa Priyadarshini Seepaul Choolhun

## Key Facts and Practical Information




| | |
|---|---|
| Official Country Name | Republic of Mauritius |
| Country Size | 2,040 km² |
| Maritime Zone | 2.3 million km$^2$ |
| Capital City | Port Louis |
| Country Population | 1.26 million (2017) |
| Official Language | English and French |
| Main Vernacular Language | Creole (common) |
| Literacy Rate | 85-90% |
| Unemployment Rate | 8% |
| Country Official GDP per Capita | US$9,627 (World Bank, 2017) |
| Income Category | Upper middle income (World Bank) |
| Currency | Mauritian Rupee (MUR) |
| International Dialing code | +230 |
| Time Zone | (GMT) +4 hours |
| Climate | Tropical; cyclone season (Dec-Apr) |
| World Bank Ease of “Doing Business" Rank | 25 out of 190 countries (World Bank, 2017) |

## A. Background

Mauritius including its outer islands of Rodrigues, St Brandon, Agalega, Tromelin and Chagos Archipelago has an Exclusive Economic Zone of around 1.9 million km$^2$.It has limited shelf areas around the islands except for larger shelf areas on certain remote banks (Nazareth, Saya de Malha and the Chagos Archipelago) situated far to the north. However, an extended continental shelf of 396,000km$^2$ was jointly conferred on Mauritius and Seychelles beyond their respective Exclusive Economic Zones on the Saya de Malha bank, in 2011, to harness the potential which the extended continental shelf offers.

Fisheries and ancillary activities (shipping agencies, port activities, logistics, vessel repairs, shipping and financial services, and crew expenditures) contribute significantly to the national economy. Industrial developments within the fisheries sector are making increasingly significant contributions to the national economy through the continued development of the Seafood Hub in the Free Port Zone since 2006. Government's strategy is to ensure the sustainable management of the fisheries resources, while facilitating the growth and development of the industrial fisheries for processing and export, transhipment of catch from foreign vessels, with the associated value addition derived from port chandlery and servicing facilities.

## B. Brief on the Ministry

The Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping was created in December 2014 to bring under one roof all ocean-related matters.

The portfolio of the Ministry relates to all matters relating to Land-based Oceanic Industry, Fisheries & Other Living Marine Resources, Seafood Hub, Albion Fisheries Research Centre, Fisheries Training and Extension Centre, Fishermen Welfare Fund, Shipping Development, Merchant Shipping, Mauritius Maritime Training Academy and Mauritius Shipping Corporation.

In line with the Government vision, the Ministry has an important role to give a boost to the Ocean Economy Sector with a view to increasing its contribution in the growth of the national economy. This sector is becoming an important economic pillar in Mauritius.

The Fisheries Division is responsible, among others, for management and policy advice, as well as for development of near-shore and off-shore fisheries and aquaculture. The Division has a total of about 400 (inclusive of Officers in the Fisheries Protection Service) funded post headed by the Director of Fisheries and assisted by Assistant Directors of Fisheries, Divisional Scientific Officers, Scientific Officers/Senior Scientific Officers, Principal Technical Officer, Senior Technical Officer and Technical Officers.

It has under its umbrella the Fisheries Protection Service, which is the enforcement arm of the Ministry responsible for the protection and conservation of fishery resources for sustainable development.

## C. Mission, Vision and Objectives

### Mission

To be an economic pillar with due regard to sustainability of aquatic resources and social development for the benefit of all stakeholders.

### Vision

To provide an enabling environment for the promotion of sustainable development of the fisheries sector and to ensure continued economic growth, social development within the framework of good governance.

**Objectives**

- Undertake fisheries and aquaculture research and development and manage resources for sustainable development;
- Consolidate existing knowledge and promote new ideas in fisheries development and management;
- Promote the development of the Seafood Hub with the collaboration of all stakeholders;
- Promote and regulate the optimal long-term sustainable utilization of living marine resources;
- Foster the interest of Mauritius within the international fisheries community, including encouraging the international trade of fish commodities within the framework of international laws and conventions;
- Build capacity, fisheries capability and skills;
- Provide professional, responsive and customer friendly services;
- Disseminate information on fisheries;
- Have a national fisheries policy responsive to the aspirations of all stakeholders; and
- Promote the social welfare status of fishermen.

**D. Strategic direction**

Enhance the contribution of the fisheries sector in the economic growth of the country through:

- Sustainable development and management focused on an ecosystem approach to fisheries;
- Continued support for the sustainable development of the seafood hub;
- Improved market access to build confidence in the export strategy;
- Development of a national fleet capacity for harvesting fishery resources around Mauritius and in the region;
- Development of aquaculture to optimize its economic contribution and to release pressure on natural fisheries resources;
- Conservation of marine biodiversity, habitats and ecosystems;
- Enhancement of the capacity for enforcement to deter illegal, unregulated and unreported (IUU) fishing in the maritime zone of the Republic of Mauritius;
- Empowerment of the fishermen community in the context of food security and the changing economic and climatic environment.
- Reinforce bilateral, multilateral and regional cooperation for the sustainable management and development of the fisheries sector.
- Reinforce the architecture of the Competent Authority - Sea Food to be in line with the requirements of the international markets.

**E. Economic outlook of the fisheries sector**

Fisheries accounts for about 1.6 per cent of GDP with a turnover of Rs. 28.55 billion in 2017. The total fish production was around 23,845 tonnes comprising about 22,596 tonnes of fish from capture fisheries and about 1,249 tonnes from aquaculture in 2017.

Total export which accounted for around 19.3% of the national export was estimated at MUR 14.27 billion and emanated mainly (> 90%) from the processing of imported fish. Total imports of fish and fish products (mainly frozen and canned) amounted to around MUR 12.63 billion resulting in a positive trade balance of some MUR 1.64 billion.

Revenue from fish licences amounted to about Rs. 60.20 million and there were 1,027 calling fishing vessels in the port which generated some Rs. 10.27 billion. Total active employment as at date is estimated to be 11 900. About 80 % of the labour force in the fish processing sector is women, thus, promoting the economic empowerment of women, which is in line with the Sustainable Development Goal.

**F. Structure of the fisheries sector**

At present five types of fisheries are practiced in the fishing industry of the country.

***(a) Artisanal Fisheries***

Around 1,900 fishermen were involved in the artisanal fishery in Mauritius in 2017 landing their catch at the 61 fish landing stations around the island. The fishermen make use of about 1,500 fishing boats, six to seven metres in length made of wood or fibreglass of which 90% were powered by outboard and inboard engines.

The total catch was estimated at around 598 tonnes in the same year. In addition, it was estimated that 650 tonnes of pelagic fishes were caught by sports and recreational fishermen and about 300 tonnes by amateur fishermen.

***(b) Banks and Chilled Fish Fisheries***

The remote banks found at around 250 to 1200 nautical miles to the north of Mauritius are exploited by Mauritian fishing vessels producing frozen fish. Steps have been taken to manage these resources with the licensing of fishing vessels as from 1992. In parallel, management measures such as the imposition of a catch quota have been implemented as from 1994 so as to ensure sustainable exploitation of the resources.

Four vessels including 2 local vessels flying foreign flags operated on the banks employing around 200 bank fishermen in 2017. The total landings from the banks fishery amounted to some 1,216 tonnes.

Some 12 fishing vessels were involved in the production of about 240 tonnes of chilled/frozen/dried fish from the St. Brandon inshore fishery.

Moreover, 15 fishing vessels operated on the St. Brandon, Albatross, Saya de Malha, Nazareth and the northern banks producing some 223 tonnes of fresh/chilled fish and involving some 200 fishermen in 2017.

***(c) Tuna Fisheries and Processing***

Mauritius is exploiting the temperate pelagic surface tuna fisheries of the Western Indian Ocean, aiming at the albacore tuna and the swordfish fishery. 994 tonnes of chilled pelagic was produced in the semi-industrial pelagic fishery.

Eleven Mauritius flagged vessels including 2 purse seiners and 9 longliners landed some 17,687 tonnes of tuna in 2017.

A tuna cannery was operational on the island from 1972 and was replaced and up-graded in 2000 to a processing plant with a capacity to process 50,000 tonnes per year. A tuna loin factory, with a processing capacity of 60 000 tonnes, started its operation in May

2005. Both companies were merged in 2015 in order to increase their export performance. Presently, about 140,000 tons of tuna are processed in the cannery.

A total of around 123,213 tonnes fish and fish products were exported in 2017. Other processing facilities based on tuna and tuna products include fish meal, fish oil and aquaculture and livestock feeds.

A total of 50,189 tonnes of tuna and tuna-like species were transhipped at Port Louis by licensed and non-licensed fishing vessels.

***(d) Deep-sea demersal (Slope) Fisheries***

The deep-water snappers occur on the slope of the banks in the Mauritian EEZ at depths ranging from 125m to 300m. The deep-water snappers are highly commercial species and are mostly marketed chilled, thus attracting business opportunities.

In 2017, nine fishing vessels were active in the fishery on the drop-offs of Nazareth, Saya de Malha, Albatross, Sphyrna, North West and Soudan Banks targeting snappers and groupers. A total of 440 tonnes of chilled/frozen fish were landed.

***(e) Outer-reef Fisheries Development – Fish Aggregating Devices (FAD) Fisheries***

Fishermen are being diverted from the heavily fished lagoon to outer-reef areas. FADs have been placed around Mauritius and Rodrigues in order to develop a fishery for pelagic fishes. Twenty FAD’s were active around Mauritius in 2017. Around 300 fishermen operated around FADs and landings amounted to some 268 tonnes of pelagic fish.

**G. Aquaculture and Potential for economic development**

The development of aquaculture limited by availability of fresh water resources has now gathering momentum through the development of marine aquaculture. This potential has come to light after a successful venture by a private sector operator to produce fish in floating cages on a commercial scale in 2002. Its operation consists of a hatchery, 6 cage farming sites, 1 processing plant and employs some 150 persons. About 30% of the sales are realized in Mauritius and the rest is exported to USA and Europe. The production at present is around 1,249 tonnes of red drum (ombrine) and the European sea bass (le bar).

For the short-term, opportunities exist for aquaculture to supply fish to the domestic market as well as the hotels and restaurants. Potential projects for aquaculture development encompass inter alia, Marine Ranching, Post Larval Capture, Coral Farming, Seaweed Culture and Pearl Oyster Culture. Potential candidates for marine aquaculture include seabream, cordonnier, mullets, cobia, red drum, bar, crab and sea cucumber.

According to the Aquaculture Master Plan of 2007, projection for Mauritius spins around an investment of MUR 5 billion (USD 167 M) with production of 29,000 to 39,000 tonnes from aquaculture for the medium to long-term, generating 5,000 direct employment.

Presently, small-scale marine aquaculture is being pursued through the setting up of 10 cage culture projects for the production of cordonnier (*Siganus sutor*) by fishermen who have grouped themselves into associations or cooperatives. 90,000 fingerlings were supplied to them in 2017.

In the past, under the resource propagation programme, hatchery-produced juveniles of marine shrimps and fingerlings of sea bream were released in the lagoon for enhancing natural stocks. This undertaking is being continued.

30,000 sea bream fingerlings were produced in the hatchery at AFRC. 10,000 were released at Albion. 350 hatchery produced crablets were released in the mangrove areas of the Blue Bay Marine Park under the Marine Ranching Project. A total of 6,720 berri rouge fingerlings have been distributed to 127 persons. 15,080 berri rouge fingerlings were sold to 13 persons. 12,700 freshwater prawn juveniles (camaron) were sold to two farmers.

**H. Research and development**

The Albion Fisheries Research Centre (AFRC) comprises the technical services of the Ministry and is responsible for carrying out research and development on fisheries and studies on the marine ecosystems. It also provides advice on fisheries management and to the fishing industry in general. Research and development activities are aimed at increasing knowledge on the fishery resources found in the Exclusive Economic Zone of Mauritius, increasing fish production and the most appropriate ways of exploiting such resources keeping in mind their conservation for sustained development i.e. a rational approach to management of all the fishery and marine resources.

AFRC also evaluates coastal development projects, Environment Impact Assessment Reports, Post Environmental Reports, post-EIA reports. It also reviews management plans for the two Marine Parks, and monitoring of ex-sand mining sites. In addition, studies are also carried out on the lagoon ecosystems, water quality and coastal oceanography. The Centre implements action plans for stranded mammals and turtles and participates as a major stakeholder in the implementation of the National Oil Spill Contingency Action Plan.

AFRC provides data on coral reef to the Global Coral Reef Monitoring Network, to the Ministry of Environment on water quality and to the Central Statistical Office and to FAO on fisheries statistics including aquaculture production.

Advice is also tendered on fisheries development projects in Rodrigues and the outer islands. The Centre conducts regular surveys to assess the sea cucumber population for both Mauritius and Rodrigues.

The Fisheries Division is also an enforcing agency for the marine environment under the Environment Protection Act.

**I. Regional and International collaboration**

AFRC also collaborates with the following international organizations for management, development, research and trade in fisheries (European Union - EU, South African Development Community - SADC, Common Market of Eastern and Southern Africa - COMESA, Japan International Cooperation Agency - JICA, Japan Tuna Fisheries Cooperative Association - JTFCA, Institut pour la Recherche et le Développement - IRD, Indian Ocean Tuna Commission - IOTC, Indian Ocean Commission – IOC, Convention for the Conservation of Antarctic Marine Living Resources - CCAMLR and through bilateral cooperation with countries like Kuwait, Greece, Pakistan, India, Seychelles, France, Mozambique, Western Australia, amongst others.

Some on-going projects are as follows: -

(a) The South West Indian Ocean Fisheries Project, a World Bank/GEF funded project to assess the fisheries resources in the EEZ of the SWIO countries;

(b) The Monitoring, Control and Surveillance regional project of the Indian Oean Commission;

(c) The Network of Marine Protected Areas of the Countries of the Indian Ocean Commission;

(d) Research projects/studies funded by IFAD/MARS and NORAD for the management of our fisheries and marine resources.

**J. The Seafood Hub**

Strategically positioned in the Indian Ocean, Mauritius is a regional hub for maritime traffic, thus facilitating the export of our finished products towards markets such as Europe, USA, the Middle East, Asia and Africa. The Government Policy is to sustain the development of Mauritius into a Seafood Hub is a high priority on the economic agenda.

The Seafood Hub is defined as: “An efficient and attractive environment for the supply of value added processes and services related to the sourcing and marketing of sea food products”. The objective of Government is to transform Mauritius into a Seafood Hub for trading, warehousing, processing, distribution and re-export of fresh, chilled and frozen or value added seafood products.

The strategy of the Seafood Hub is focused on the development of value added fisheries and seafood related sectors including fishing, transshipment, storage and warehousing, light processing, canning, ancillary services (ship chandelling, bunkering, vessel husbandry, ship agency, ship building and repair).

To-date a One Stop Shop service is in place at the Trade and Marketing Centre (TMC) in the free port area to facilitate the administrative procedures for loading/unloading/export of fish and fish products.

**K. Port State Control Unit**

A Port State Control Unit is based at the One Stop Shop which facilitates and provides expedient services to operators and comprises of the Ministry, the Competent Authority-Seafood, Customs Department, the Ministry of Health and Quality of life and the Passport and Immigration.

An inspection unit within the Port State Control Unit of the Ministry of Fisheries also verifies the IUU vessel list of the IOTC, CCAMLR and other regional fisheries monitoring organizations to check whether any vessel is on the list and as well as taking into consideration the CCAMLR conservation measures regarding toothfish fishing vessels. On arrival of authorized vessel, boarding and inspection are carried out for the collection of document and verification of catch.

**L. Competent Authority**

As per the Fisheries and Marine Resources (Export of Fish and fish Products) (Amendment) Regulations 2010, the “Competent Authority” means the Seafood Unit of the Ministry responsible for the subject of fisheries and marine resources. Thus, the Competent Authority verifies and certifies fish and fish products intended for export. The Competent Authority also ensures that all sea food processors operate in accordance with international seafood norms and standards (HACCP, SPS & EU Regulations). The fish products in the Seafood Hub deals with canned tuna, pre-cooked vacuum packed tuna loins, frozen fish fillets, fresh chilled whole fish/fish fillets, cured fish, smoked fish, salted fish, pet food, fish oil and animal feed. The main market for canned tuna is the EU whilst tuna loins are mainly exported to the US.

**M. Fisheries Protection Services (FPS)**

The FPS is a full-fledged enforcement arm of the Ministry of Ocean Economy, Marine Resources, Fisheries & Shipping with proper infrastructure, logistic and equipment. It caters for an efficient control over the fishing activities not only in lagoon and off lagoon but also in respect of regional fishing under bilateral conventions and regional cooperation with joint patrol under the Monitoring, Control and Surveillance (MCS) Programme in the EEZ and over territorial waters of Mauritius. Officers of the FPS operate at its Head Office in Port Louis and at four regional headquarters with a number of Fisheries Posts under each regional headquarter and its Flying Squads.

The Prosecution Unit was set up in the year 2007 and is headed by an Assistant Controller who is assisted by four Principal Fisheries Protection Officers who act as Prosecutors.

**N. Training and capacity building**

The Fisheries Training and Extension Centre (FITEC) situated at Pointe aux Sables was set up through a grant from the Government of Japan and became operational in October 2004 and is ISO 9001:2008 certified.

The Center provides training to fishermen and other stakeholders of the fishing industry in order to meet government's fisheries development objectives that are:

- Empowering fishermen to earn a better livelihood.
- Enhancing knowledge and skills of fishermen to operate in the off lagoon area around Fish Aggregating Devices and the oceanic banks;
- Encourage effective and efficient fishing techniques;
- Provide training for enhanced safety and security at sea and in navigation;
- Creating awareness on the protection and conservation of the marine environment; and
- Promoting an ecosystem approach to fisheries.
- Enhance fish handling, preservation and marketing.

FiTEC carries out demonstration fishing for the following fishing projects:

- Deepwater shrimp fishing using fishing pots
- Swordfish and tuna fishing using the longline fishing techniques
- Demersal handlinefishing targeting demersal species
- Slope fishing for deep demersal species using the dropline fishing techniques
- FiTEC is also called upon to identify new fishing grounds
- Development and improvement of fishing methods and gears

**O. Sustainable management measures**

Fish stocks are preserved by dictating the level of exploitation of fish resources through the consolidation of existing input and output control measures such as the close season for the net fishery, restriction of destructive fishing methods, limitation on gear and mesh size, licensing system, quota allocation, size limit and encourage the relinquishing of net through a voluntary buy back scheme.

Measures to sustain fishery development include banning of underwater fishing and fishing with explosives, closed season of six months for net fishing in the lagoon and regulations on undersized commercial fishes, banning of fishing with cast nets since 1998, moreover with a view to phase out net fishing, a Nets Buy Back scheme was introduced in 1996, whereby fishermen are encouraged to relinquish their nets upon payment of compensation, reduction of fishing pressures in the lagoon by encouraging artisanal fishers to fish off-lagoon, setting up of Fish Aggregating Devices around Mauritius in order to relocate fishing effort to offshore areas, training of fishers and loan facilities at low interest rates through the Development Bank of Mauritius to registered fishers for purchase of boats for off-lagoon fishing.

A Banks Fishery Management Plan has been prepared in 2013 using the precautionary approach and the Ecosystem Approach to Fisheries. Regulations for the collection of sea cucumbers were proclaimed in September 2008 and a moratorium has been put forth from 1 March 2012 to 29 February 2016 to allow the sea cucumber population to recuperate. This has been extented till 2021. A close season of three months corresponding to the spawning season of octopus has been introduced since 2015 for the octopus fishery.

A Port State Control Unit is in place to implement Regional and International Marine Conservation Management Measures. A National Plan of Action (NPOA - IUU) to combat illegal, Unreported and Unregulated Fishing is under implementation since 2010. Fishery stocks and by-catch are better managed.

**P. Development of the Ocean Economy**

Government's vision is to make of Mauritius, within the next ten years, a nation fully conscious of its immense potential as an ocean state. This is a key channel through which we can advance economically to greater prosperity. In this context, a new Ministry dedicated to ocean related activities has been created.

The main clusters of the Ocean Economy include:

- Fisheries and Aquaculture
- Deep Ocean Water Applications (DOWA)
- Tourism and Leisure
- Seaport related activities and services
- Marine renewable energies
- Seabed Exploration for Hydrocarbon and Minerals
- Ocean knowledge

The Ocean Economy has wealth generation and job-creating potential since Mauritius is endowed with a vast EEZ which housed valuable untapped resources. This vast extent of ocean represents an area bigger than the combined land area of France, Germany, Italy, Spain and the United Kingdom.

Currently, the ocean economy's share of GDP is estimated at around 10%, out of which 90% which comes from three established sectors – coastal tourism and marine leisure, seaport-related activities and seafood-related activities. Emerging activities of the ocean economy such as DOWA, Marine renewable energy, ocean knowledge, seabed exploration for hydrocarbon and minerals, marine ICT, marine finance and insurance, marine biotechnology are new economic opportunities for diversification and expected to double the contribution of the ocean economy in the medium and long term.

**Q. Existing export market and others being explored**

| Existing export market | Markets being explored |
|---|---|
| EU/UK | Russia |
| USA | S. Africa |
| Reunion Island | Korea |
| Australia | |
| China | |

**R. Incentives/Facilities to Fishermen**

Various schemes have been introduced by the Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping with a view to assist the fishermen community. These facilities include:

- VAT refund on purchase of outboard motors
- Bad Weather Allowance
- Close Season Allowance
- Insurance Cover
- Phasing out of net fishing
- Financial Purchase of boats known as "Canotte"
- Financial assistance for purchase of semi – industrial vessel
- NPS (National Pension Scheme)
- Assistance under Fishermen Welfare Fund (FWF) such as grants and scholarships
- Promotion of small-scale aquaculture
- Projects under capital budget
- Marine ranching and stock enhancement
- Grant of Floating cage structure for fishermen cooperative

**S. Possible areas of collaboration which Mauritius could envisage with other countries**

States, in accordance with their respective laws and regulations, may cooperate with each other on the basis of equality, friendship and mutual benefits in the areas of fisheries and aquaculture including:

(a) aquaculture research and development;
(b) marine aquaculture (culture of fish, oyster, seaweed and abalone species and techniques, seed production and feed production and management);
(c) training and human resource development;
(d) exchange of information and technology transfer
(e) development of innovative fishing techniques;
(f) the prospection and fish stock assessment;
(g) the sustainable exploitation and responsible management of fisheries resources;
(h) investment in fish processing and value addition in the seafood industry;
(i) collaboration in the trade of fish and fish products;
(j) promoting biosecurity and aquatic animal health management;
(k) capacity building in the field of marine conservation, protection and management of marine protected areas;

(l) collaboration on Monitoring, Control and Surveillance and to combat Illegal, Unregulated and Unreported fishing in their respective Exclusive Economic Zone through information sharing; and

(m) any ancillary item to any of the above.

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# FISHERY SECTOR IN OMAN

Nabila KulmairHaiderAl.Bulushi

The Sultanate of Oman, whose capital city is Muscat, is an Arab country situated in the south east of the Arabian Peninsula, with an area of around 300,000 km2. It is bordered by the United Arab Emirates (UAE) in the northwest, Saudi Arabia to the west, Yemen in the south, with the Arabian Sea to the southeast and the Gulf of Oman to the northeast. Oman is divided into 11 governorates. Musandam is one of these governorates, an exclave of Oman that is surrounded by the United Arab Emirates. This governorate has itself an exclave in the UAE, called Madha (75 km2), which amazingly contains an ever smaller exclave of the UAE called Nahwah. Musandam is jutting into the Strait of Hormuz at the end of the Persian Gulf.

Oman has generally a very hot and dry climate with little or no rainfall except in the Dhofar region and is mostly covered by desert and mountains isolating the country from the rest of the region.

The Omani population is estimated to be around 3.9 million in 2014 (www.worldbank.org), composed of mainly Arabs but also Indians, Pakistani and several African groups (www.populstat.info). An important group within the current Omani population is formed by non-Omani Citizens who are mainly migrant workers.

## Fishing industry in Oman

Oman has a shelf area of 54,000 km2 and an EEZ of 536,000 km2 (www.seaaroundus.org), and opens to two different seas: the Gulf of Oman and the Arabian Sea. Two main factors made the fishing sector very important for the Omani economy and culture. First of all, Oman is separated from the rest of the Arabian Peninsula by a natural barrier, the Rub al Khali, i.e., largest sand desert in the world. Thus, most of the country's connections with the rest of the world have to be made by sea (Metz 1993). Oman also has a strategic position on one of the most important maritime trade routes connecting the Gulf, southern Asia, the Mediterranean and East Africa.

During the pre-oil period, the fishing sector was the second contributor to the economy (after farming). However, with the expansion of the oil industry, fishers started leaving their boats for a more remunerative activity. Thus, in the early 1970s, the government started developing and organizing the fishing sector by establishing the Fisheries Department followed by the creation of the Ministry of Agriculture and Fisheries (MAF) (Alhabsi et al. 2011); in 1978, it started subsidizing the fisheries, via a "Fishermen's Encouragement Fund" to increase employment in the fishing industry (Metz 1993; FAO 2001). During the 1990s, the Omani government decided to invest even more in potentially sustainable sectors, and thus funded several fisheries development and research projects (e.g., Oman Fisheries Development and Management Project) (Metz 1993). In 2007, the Ministry of Fisheries Wealth was formed (Alhabsi et al. 2011); Oman is also member of the Indian Ocean Tuna Commission and the Regional Fisheries Commission (Morgan 2004).

Until 1980, the Omani fishing industry was only artisanal. In 1980, an industrial fishery was launched, after fishing agreements between Oman and other countries were signed (Morgan 2004). Thus, from 1980 to 2010, two sectors co-existed in Oman: artisanal/coastal (or ‘traditional’) and industrial fishing.
Fiberglass boats are the most common, i.e., 93% of artisanal vessels in 2010. Dhows are mainly used in the governorate of Alsharqiah, i.e., in the eastern part of Oman, and Shashas in the governorate of Albatinah, in thenortheast.The fishers use a mixture of fishing gears including hand lines, traps and gill nets, etc., depending on the target species and season.

## FISHERY SECTOR IN SRILANKA

**M. Manoja Priyadarshani De Silva Jayatilake**

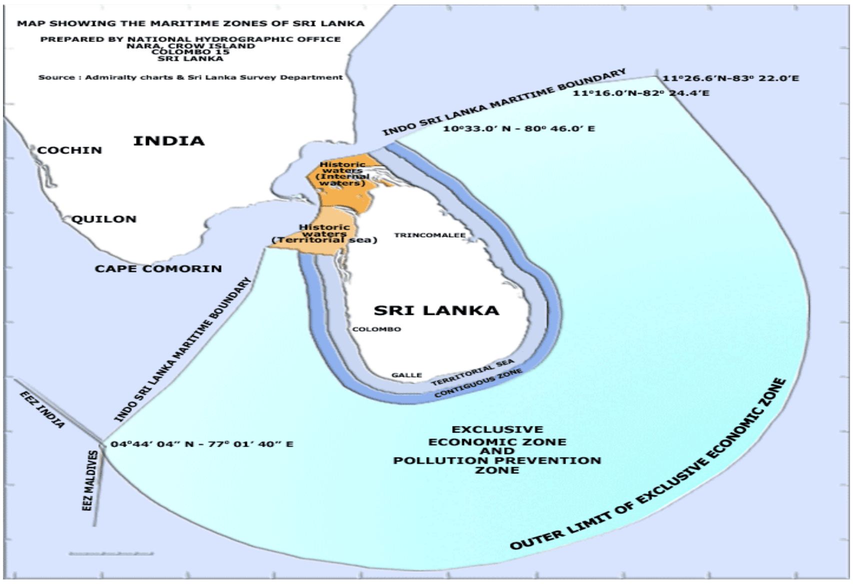
### Introduction about Sri Lanka

Sri Lanka (formerly Ceylon) is an island nation south of India in the Indian Ocean. Its diverse landscapes shape range from rainforest and arid plains to highland and sandy beaches. It's famed for its ancient Buddhist ruins, including the 5$^{th}$- century citadel Sigiriya, with its palace and frescoes.

Sri Lanka's land area with 65 610 sq.km, between 5° 55' & 9° 50' North Latitude and Between 79° 31' & 81° 53' East Longitude. Distance of SriLanka is 433km North to South and 226km West to East and

The temperature is Low country-min. 24.7° C - max. 32.6°C and Hill country -min. 18.5° C -max.27.7°C

### Overview of the Fisheries sector in SriLanka




Country has narrow continent shelf with an average width of 22km.Territorial sea of 21,500Km$^2$ EEZ of 517,000Km$^2$Length of Coastal Shore-line is 1817 km and the EEZ is seven times bigger than the land area.

Sri Lanka fisheries sector is divided into two parts are Marine sector and Inland and Aquaculture sector. Marine sector subdivided into another two parts are called Coastal water and Offshore/Deep Sea water.

Further Inland and Aquaculture sector is subdivided into two parts are called Capture Fisheries and Aquaculture.

Ministry of fisheries& Aquatic Resources Development and Rural Economic is done formulation of policies & strategies, managing and supervision in the Fisheries sector in Sri Lanka and it has 06 sections. There are NARA (National Institute of Fisheries Research), NAQDA(National Authority of Aquaculture), CFHC (Ceylon Fisheries Harbor Cooperation), DFAR(Department of Fisheries & Aquatic Resources) , CFC(Ceylon Fisheries Cooperation) and CEY-NOR.

**NARA-** This Institute is done all the scientific research in the fisheries Sector.

**NAQDA-** This Institute is done all the activities for development of Inland fisheries & Aquaculture in SriLanka.

**CHFC -** Management & development of harbors and anchorages.

**CFC-**Management of marketing in the Fisheries sector.

**CEY-NOR** - Input supply (Fishing Gear etc..)

**DFAR**

Department of Fisheries & Aquatic Resources is functioning under Director General in accordance with the Fisheries & Aquatic Resources act No. 02 of 1996. The Head Office is divided to six important Divisions for the efficient discharge of the Departmental functions.

1. Fisheries Management Division
2. Fisheries Industries Division
3. Monitoring, controlling and surveillance Division
4. Fishery product Quality control Division
5. Finance Division
6. Administration Division

Additionally a High Seas Management Unit and a Lagoon Management Unit is also functioning under this department. Latest adding to the organization is the Vessel monitoring center which manages the high seas fisheries flee though satellite based monitoring system.

In addition to the Head Office, there are fifteen (15) District Assistant Directors' Offices along the coastal districts of the island. There are one hundred and forty eight (148) Fisheries Inspectorate Divisions under the District Offices, covering all fisher's villages. There are about 18 Harbor officers to manage the High Seas Fisheries Activities and 21 Radio Communication Centers to deal with the communications with Multiday Boats.

**Brackish Water Fisheries**

Sri Lanka is endowed with over 116 lagoons and estuaries along its coastline. These brackish water bodies serve to protect the island's coastal regions and communities from extreme natural phenomena, while contributing to the country's food security as well as providing means of livelihood to hundreds of lagoon-dependent coastal communities.

Following a successful pilot project; Sustainable Lagoons and Livelihoods to establish site-specific collaborative governance systems in 18 selected lagoons in Sri Lanka, the BMU intends to replicate this system of co-governance in all brackish water bodies in the island. Collaborative governance entails facilitating collaboration between hierarchical and self-governance systems to ensure joint exercise of economic, political and administrative authority to responsibly utilize Sri Lanka's lagoon and estuary ecosystems and resources. Collaborative governance of brackish water bodies, local people along with all other stakeholders take up the process of self-organizing that takes into consideration of "users and rulers together" in order for the preservation, protection, management and utilization of the unique ecology of each of these water bodies.

**Coastal Fisheries**

In terms of production and employment, those fisheries taking place within the continental shelf and undertaking by fishing craft in single day operation was the dominant sub sector and always made the largest contribution to the national fish production. This will be continued up to a certain extent in the plan period as well. In view of the bio physical limitations and the changes being taken place in the near shore coastal environment, it is important to forecast and place more emphasis on the inland, offshore/deep sea and brackish water fishery resources adapting effective technologies to increase the fish production. Strategies have been made in this plan to exceed the coastal production by offshore/deep sea fishing after the midyear 2011.

Hence the total sustainable yield from the coastal sector would be 250,000 Mt assuming the same density of biomass as obtained during the surveys in the northwest. Although the coastal fish production by 2013 has been targeted around 258,000 Mt in this strategy assuming the areas that were not properly surveyed are the most productive fishing grounds in the coastal waters of Sri Lanka and therefore it is sensible to assume that the density of biomass is highest in these areas and the potential in reality be higher than the estimated 80,000 Mt.

**High Seas Fisheries**

Until 2013 the application of Sri Lanka’s legal framework for fisheries was limited to fishing activities conducted with the Exclusive Economic Zone of Sri Lanka (EEZ). However due to the build-up of a fleet of multi-day fishing boats which have started conducting fishing operations in the high seas beyond the boundary of the EEZ the need arose for controlling and managing high seas fishing. One of the main factors that necessitated such management was that Sri Lanka has subscribed to a number of international conventions and agreements on fisheries which have been enacted under the United Nations Convention of the Law of the Sea.

As a state which has subscribed to a number of international agreements and conventions on high seas fishing, Sri Lanka stands obliged to comply with requirements and provisions in those agreements. As a result of certain deficiencies in complying with such requirements, Sri Lanka has lost its right to export fish to its most important market namely, countries in the European Union from January 2015. This export has very adversely affected the country’s economy in general and the fishing communities and the export business establishments in particular. Therefore Sri Lankan Fisheries Management Authorities were given the task of establishing the procedures and management measure that would assist to establish responsible fisheries cultures which also help to revoke the EU fish export ban.

Accordingly, a number of policy decisions were taken, new management procedures were developed to control activities of fisheries vessels at high seas to ensure that the fisheries activities are not carried out in an illegal, unreported and unregulated (IUU) manner. These processes were fairly new to Sri Lankan culture and can be considered as a novel level of knowledge. However conveying the knowledge to the stakeholders especially for the fisheries officers is a challenge. Although many training sessions were carried out, it was decided that having a comprehensive and user-friendly guide would assist relevant officers and stakeholders to follow the correct procedures so that the coordination process will be facilitated.

The sole focus of this exercise is to encourage officers and stakeholders to establish a responsible fisheries culture in Sri Lankan Fisheries sector.

**FISHERY SECTOR IN SUDAN**

Fatima Yousif Mohammed Ahmed

**Introduction:-**


Sudan is the one of the largest country in Africa it's an area 1.880000 Km2, situated between Longitude22 ° 38' E and Latitude 22° 4 ' N and total population 33.419.625. Sudan borders seven countries {Egypt, Eritrea, Ethiopia, South Sudan, Central African Republic, Chad and Libya}.

This vast country embraces different vegetation patterns reflecting various climatic zones, annual rainfall ranging between 25 mm and 1000 mm

**The main sources of fisheries in Sudan:-**

**River Nile ( Man made lakes)**:-

Gebel Aulia Reservoir, Roseries Reservoir, SennarReservoir, Khishm El GirbaReservior Lake Nubia & Merowe.

Dinder, Rahadrivers& other River Nile tributaries

Impoundments & Irrigation Canal.

**- Red Sea.**

**- Aquaculture.**

**Fresh water**

Capture:

125 species (44 - 48) is commercial and have economic value .

The taxonomy of the aquatic fauna and flora is neither accurate nor complete , not all inland waters have been surveyed.

**MARINE FISH RESOURCES IN SUDAN**

* The (Red Sea) marine coast of Sudan is 750 Km in length. The economic zone area is

9,800 Km2, 800 Km2 of this economic zone area is deep water with flat bottom suitable for trawling.
*The rest 9000 Km2 is suitable for traditional fishing. The total annual marine resources production amounts about 5000 – 8000 tons.
The Sudanese Red Sea supports high biodiversity including about 200 species of soft and hard corals, 300 species of bony fishes, over 50 species of sharks and rays and 1,000 species of invertebrates.

**Aquaculture:-**

Establish National Freshwater Aquaculture Center (serve as Genetic Improvement of local strain).
Providing Floating Fish Feed Manufactures.
Technical assistance (Fish Hatcheries for Tilapia &Clarias), Aquaculture Equipment & tools.
Tilapia sp. (40%), Clarias (50%) is common cultured species in Sudan depend on local markets demand.

**Fish processing:-**

- Wet salted fish
- Sun dried fish
- Fish maw
- Smoked fish
- Sea cucumber

**Fish certificate:-**

- Supplier name & address.
- Name and identification number of fishing vessel or name of aquaculture unit.
- Data of catch or harvest.
- Quantity.
- Predominant area where caught or farmed.
- Category of fishing gear used.
- Commercial designation and scientific name for species

**Substance:-**

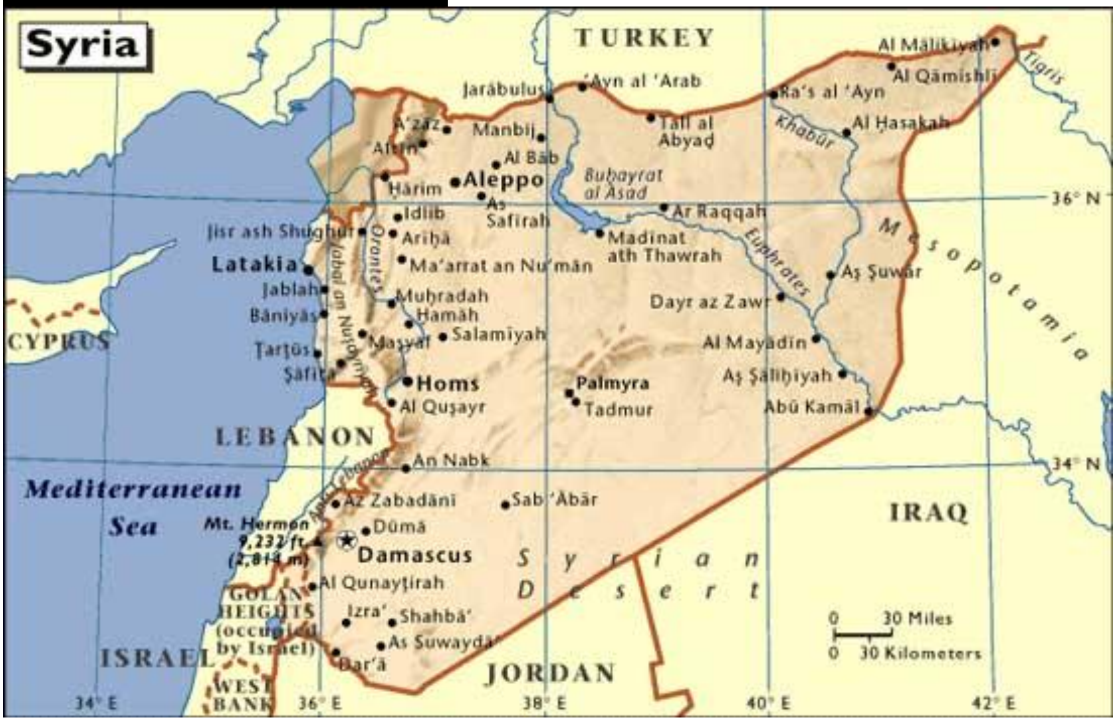
- Trawl vessels
- Boat for artisanal
- Fish finder
- GPS
- Patrolling boat
- MCS tools
- Training

**Capacity Building** (Training, Technical skills and technical support on fish culture services

**FISHERY IN SYRIA**

Ali Suleiman and Bassem Bufroud

**Introduction :**




The Syrian Republic is located in the southwestern part of the continent of Asia; Where overlooking on the Mediterranean Sea from the west , It is bordered to the north by Turkey, from the east and south by Iraq, from the south by the Kingdom of Jordan, from the west byMediterranean sea and Lebanon.

The area of the Republic of Syria about 185 thousand $km^2$, and the number of its population in 2013 was estimated at 22.5 million people. The city of Aleppo is the largest city in Syria, while Damascus is the largest population.

Syria has a good number of rivers if compared to other Arab countries. The Euphrates River is the most important with length approximately 610 km. The Tigris River, which crosses the Syrian-Turkish-Iraqi border for a length of about 50 km.Other rivers also known in the northern region is the Quiqriver and the Afrin river.The Great Northern River flows into the Mediterranean Sea in northern Syria .Yarmouk River south of Syria

There are other rivers, but small compared to the previous ones, such as Baradariver and Sagur river.We suffer a very bad circumstances because of the war wich destroyed most of my country's bounties including the fisheries sector.

**The fisheries establishment in Syria :**

The general authority for fish resource development.

Fisheries gear :
Trawel net -- Gil net
Long line hook--Traps
Squid jigging

Fish species :
Mullet---Shrimp
White seabream
Sardinia---Mackerels

# FISHERY SECTOR IN TANZANIA

Gladys Kedmon Manyika and Batuli Mohammed Yahya

## 1. Introduction

The United Republic of Tanzania (URT) is a coastal state, bordering the Western Indian Ocean (WIO) region. It is composed of Tanzania mainland and Zanzibar Island. Zanzibar is semi-autonomous part of URT which means it has its own government (Revolutionary Government of Zanzibar, RGZ). It consists of two islands called Unguja and Pemba, with about 50 other small islets forming the Zanzibar archipelago. URT has a total land area of 945,000km$^2$out of which 942,550 km$^2$ is in the mainland and 2450 km$^2$ is in Zanzibar. The total inland water area is 62,000 km$^2$, the distribution of which is as follows, 35088km$^2$ Lake Victoria, 13,489km$^2$ Lake Tanganyika, 5,760km$^2$ Lake Nyasa, 3,000km$^2$ Lake Rukwa, 1000km$^2$ Lake Eyasi, and 1000km$^2$ other small water bodies. Most of these water bodies have substantial fisheries resources. On the marine side the country has a territorial sea area of about 64,000km$^2$ and coastal line of 1,424km. The EEZ is up to 200 nautical miles covering an area of 223,000km$^2$ providing the country with additional marine area and fisheries resources (Source: Ministry of livestock and fisheries Development, 2011)

Within the URT framework, each government has full mandate over the management of the fisheries located in its territorial waters (12 nautical miles) and internal waters. The fisheries taking place in the territorial waters and the internal waters of mainland are managed under Department of Fisheries under the Ministry of Livestock and Fisheries Development and in Zanzibar are managed under the Department of Fisheries Development (DFD) in the Ministry of Agriculture, Natural Resources, Livestock and Fisheries. The Exclusive Economic Zone (EEZ) is managed by the Deep-Sea Fishing Authority (DSFA).

The continental shelf extends 4 km offshore, with exception of the Zanzibar and Mafia channels where the shelf extends to 60 km. The area of the shelf within the 200m depth contour for both mainland Tanzania and Zanzibar combined is about 30,000 km$^2$. The islands within the continental shelf include Unguja, Pemba and Mafia as well as numerous small islands, islets and sand dunes surrounded by reefs such as Latham, Tutia, Songosongo and Mbudya. Important ecosystems include mangrove forests, estuaries, coral reefs, sea grass beds, and inter-tidal flats, muddy and sandy beaches.

## 2. Fish Production

### I. Capture Fisheries

In the URT fishery is mainly artisanal characterized by the use of several gears mostly of low technology and low capital. There are 238,829 fishers using 67977 fishing crafts (National annual fisheries statistics 2016 and Department of Fisheries Zanzibar). Very few commercial/industrial vessels of purse seines and long liners owned by Distant Water Fishing Nations (DWFN) operate under Tanzanian license in our Exclusive Economic Zone (EEZ) targeting Tuna and Tuna like species. Total fish production was estimated to be 379,969.09metric tons in 2016 which include 308771.59 metric tons for inland waters, 53823.30 metric tons for marine artisanal fisheries and 17374.2 metric tons for EEZ. In land capture fisheries contributed 85 %of Tanzania's total fish production, with the principal fishery being that of Lake Victoria. The lake accounted for 238,096.80 metric tons of the country's total annual fish production in 2016. Other freshwater-bodies of commercial importance include Lakes Tanganyika and Nyasa.

**II. Aquaculture**

Aquaculture in Tanzania is dominated by freshwater fish farming in which small scale fish farmers practice both extensive and semi-intensive fish farming. In Fresh water fish farming, there are 20276 fish farmers with 22785 ponds covering an area of 25451 $km^2$ with a total production of 3,239,986 kilograms (Annual fisheries statistics report, 2016). Fish species cultures are mainly *Oreochromis niloticus*, *Clarius gariepinus* and trout.In mariculture, fish species such as milkfish, prawns, mud crabs, seaweed and pearl oyster are cultured. According to Fisheries statistics of 2016, there are 1171 milkfish farmers with 411 ponds covering an area of 160,050 $km^2$ with an estimation of 604625 kg production, 41 prawn (*Peneaus monodon*) ponds covering an area of 370,007 $km^2$ with an estimation of 407550kg production, 18 mud mud-(*Scylla serrata*) fattening farmers owning 2 ponds and 200 cages with a production of 2750kg, 5000 seaweed farmers with a production of 1,170,500kgs and 1 pearl oyster farmer with a production of 864 pieces.

However in Zanzibar islands, seaweed farming is a well-established industry employs 23,654 farmers and produces more than 15,000 tons per year; seaweed exportation brings in foreign money and gives coastal people, especially women, an opportunity to earn an income for themselves and their families. The cultivation involves two species of red algae, namely, *Eucheuma denticulatum*, known commercially as *Spinosum* and *Kappaphycus alvarezii*, known as *Cottonii* which are used for the high-value extract known as carrageenan which is used as stabilizer, emulsifier, or thickening agent in various food additives, cosmetics, and pharmaceutical products

**3. Fish Consumption**

In Tanzania mainland, per capital consumption of fish is still low. According to statistics provided by the Ministry of Livestock and fisheries development in 2016, mainland Tanzania has 7.6 kg consumption of fish per person annually, which is below the estimate of 14 kg annually provided by W.H.O. In Zanzibar, per capita fish consumption is higher, 25kg/person annually. This is because fish is a major contributor of animal protein in the diet of the average Zanzibaris and is almost the only animal protein for the lower income groups in the population.

**4. Fisheries export data**

Exports of marine products include shrimp, sea cucumber, shells, lobsters, crabs, squid, octopus and sardines. However, the majority of export revenue comes from the harvest of shrimp or prawns. In 2016, the country earned over US$ 6,245,747.558 from export of 39,691,462.0 metric tonnes of fish and fishery products. Import of fish and fisheries products from the foreign countries was 13,917,656.98 kilograms and royalties earned from imports was. US$ 372,043.98

**5. Role of Women in Fisheries Sector**

Women are being marginalized in the fishing industry and their involvement is being limited to small scale, lower remuneration tasks of processing native species such as sardines. The nature of fishing areas and their development has played a crucial role in promoting gender disparities. Traditionally, men used to fish offshore while women concentrated on inshore activities through collection of octopuses and seashells, usually during spring tides using hands and long wooden sticks or metal rods and they also engage in fish processing activities such as smoking, drying and trading within their locality. In Lake Victoria, women occupy a central place in fishing sector, they predominate representing about 70-87% of artisanal fish trade.

# FISHERY SECTOR IN TUNISIA

Rafik Nouaili

## Introduction

Tunisia occupies a central place in the Mediterranean Sea and dispose of approximately 2 300 km of littoral length. In more of this long coast, Tunisia disposes of 7 lagoons, covering a total surface of 105 200 ha and an exceptional continental shelf of a few 88.000 Km2.

The geographical distribution of the Tunisian waters as well as their stretch and the differences they have, bring about the development of very variable ecosystems. It is bordered by Algeria in the west and Libya in the south-east. An abrupt southern turn of its shoreline gives Tunisia two faces on the Mediterranean. Both played a prominent role in ancient times, first with the famous Phoenician city of Carthage, and later, as the Africa Province, which became known as the bread basket of the Roman Empire.

Tunisia has a diverse economy, with important agricultural, mining, energy, tourism, petroleum, and manufacturing sectors. Under the agreement Tunisia will gradually remove barriers to trade with the EU and developed country over the next decade. Broader privatizations, further liberalization of the investment code to increase foreign investment, and improvements in government efficiency are among the challenges for the future of Tunisia.

## II. Coastal fisheries background of Tunisia

Agriculture and fisheries have contributed significantly to Tunsian's GDP (13%), industrial growth and exports for many years. The fishery and aquaculture sector in Tunisia is playing a pivotal role in providing a livelihood for thousands of people across the region.

Lagoons and freshwater resources have made Tunisia an important supplier of fishery products of various types since ancient times. With the development of the processing industry, Tunisia could successfully expand her product range in accordance with customer needs.

Fishing and aquaculture are important economic activities in Tunisia. While the fishing sector's contribution to the gross national product less than 1%, its impact is highly significant as a source of employment in areas where there are often few alternatives. In addition, it helps to supply on the Tunisian food security.

With a production of almost 120 thousand tons of fish, in 2017, from fisheries and aquaculture, Tunisia is one of important country largest fishing power in Africa. Yet, while more than 26 thousand tones of fish products were exported in 2017.

Exports of fishery commodities were valued at around $ **300.000** in 2017 and accounted for an important percentage of Tunisian's total agriculture export earnings.

### ***Fisheries and Aquaculture production***

The fisheries sector experienced a period of decline during the 1990s but has been making a comeback, regaining much if the ground lost during the last decade. The sector's output remains well levels reached in the early 1990s.

In fact, the production of fish continued to grow and reach 102 tons in 1988, experienced a decline during the 90 years, then resumed slowly and reaches this production of 110 tons in 2016. It is only during these five recent years that fisheries production reached an average of 110 thousand tons / year essentially due to promotion and development strategy of fishing blue fish in Tunisia. The quantity exported, mainly to the EU is about 20 000 tons.

Despite the phenomenal global growth, Aquaculture contribution to the fisheries production has remained disconcertingly low, accounting for less than 3 % of global production. While the authorities show a real willingness to promote this sector and despite the existence of great potential, the current production remains at around 3 500 tons. The value of exports of aquaculture sector is around 29 million Tunisian dinars (DT) in 2005 (the equivalent of almost 22.3 million U.S. dollars). The aquaculture sector currently offers more than a thousand post jobs directly and permanently.

**<u>Infrastructure (Harbors and fishing fleet)</u>**

Tunisia has 41 maritime fishing ports. These ports can be classified, according to their importance, in two categories:

- 10 large ports, allowing to shelter the trawlers, the tuna boats, the light fishing boats and the units of fishing inshore. These ports are in (Tabarka, Bizerte, Goulette, Kélibia, Sousse, Monastir, Mahdia, Sfax, Gabès and Zarzis)
- 31 coastal fishing ports and shelter for inshore fishing and also ensure the adequate services.
- In addition to this harbour infrastructure, there are several sites of unloading, particularly on the level of the lagoons.

**<u>Flotilla and maritime population</u>**

The General Census of Fisheries 2003-2004 led to update the size of the fleet and the operational people in the Tunisian fishing sector. Indeed, there were 10949 Census fishing units and a maritime population represented by 10 000 people (Table 2).

**Tableau 1 : Flotilla and maritme population**

| | **Fish flotilla** | | **Maritime population** | |
|---|---|---|---|---|
| | ***Moyenne 1999/2003*** | ***004*** | ***Moyenne 1999/2003*** | ***200 4*** |
| Coastal boats | 12279 | 0073 | 36597 | 280 67 |
| Trawlers | 421 | 32 | 5878 | 570 3 |
| Senners | 403 | 65 | 4910 | 461 9 |
| Tuna | 60 | 0 | 665 | 664 |
| Mixed | 19 | 9 | 180 | 180 |
| Total | 13182 | 0949 | 48230 | 392 33 |

**Evolution de la flottille de pêche pour les années 2000, 2006, 2012 et 2016.**

| | 2000 | | 2006 | | 2012 | | 2016 | |
|---|---|---|---|---|---|---|---|---|
| **Type d'embarcation** | | **art du total (%)** | **N ationale** | **art du total (%)** | | **art du Nat (%)** | | **art du total (%)** |
| **Coastal boats with motor** | 730 | 4% | 45 20 | 7% | 602 | 8% | 037 | 6% |
| **Coastal boats with motor** | 840 | 9% | 59 81 | 9% | 508 | 1% | 690 | 8% |
| **Trawlers** | 45 | % | 40 0 | % | 03 | 6% | 02 | % |
| **Senners** | 85 | % | 36 8 | % | 48 | 7% | 73 | % |
| **Tons boats** | 0 | % | 44 | % | 8 | % | 8 | % |
| **others** | 28 | % | 22 5 | % | 36 | 9% | 7 | % |
| **No actif boats** | 362 | 0% | 76 0 | % | 02 | 9% | 301 | % |
| **Total** | 3850 | 00% | 12 298 | 00% | 2637 | 4% | 3908 | 00% |

**<u>Details of Tunisia's coastal fish</u>**

The coastal fisheries in Tunisia remains one of the few sectors of the national economy offering significant potential in terms of production, job creation and integration of a wide range of the Tunisian population (women, men, young or not so young) to the labour market.

Coastal fish include a broad social range of maritime population whtich live mainly from the exercise of fishing and its annexes (repairing nets, making fishing gear…).

**- Coastal fisheries in terms of production**

During this decade, the average of coastal fisheries production is about 27 500 tons for an average value of 110 MD corresponding respectively to 28% and 40% of the national production (in quantity and value) (Table 1, Figure 1 & 2).

Figure 3 point out that only the curve of coastal fisheries presents a speed downlink (negative slope).

The analysis of regional production of coastal fisheries shows that the bulk of national production, 48% in quantity and 63% in value, comes from southern Tunisia areas. The North and central areas presents respectively 34% and 27% in quantity and 26 and 19% in value (Figure 4 & 5).

**- Flotilla of fisheries coastal**

The General Census of Fisheries 2003-2004 was inventoried 10073 coastal boats, not counting the 789 boats annexes (nets doors, and doors Shkif groups) accompanying seiners and tuna boad. The number of coastal boats grew by 12% during the period 1997-2003.

1/3 of this fleet is made up of small rowing boats whose length does not exceed five metres with an average age of 23 years.

**- Maritime population of fisheries coastal**

Tunisia's maritime **population is composed** almost of coastal fishermen (coastal fisheries: more than 60%). The major part of this population is concentrated in the southern region.

**FISHERY SECTOR IN UGANDA**

Francis Xavier Gwazo

**Country Profile:**

- Uganda is a land locked country located in East Africa and lies astride the equator between latitudes 4 12N and 1 29S, longitudes 29 34E and 35 0W.
- It has a total land area of 241,038 sq km of which 42,383 sq km (18%) is covered by water in form of lakes, rivers, Streams, dams and swamps.
- The highest point is at 5110m above sea level at margherita the peak of mt. Rwenzori in the west of the country.
- The total population is estimated at 44,775,462 by November 2017 with a median age of 15.9 years ( United nations estimates) and annual population growth rate of 3.28% and a Population density is at 222 persons per sq Km.

**Fisheries sector**

- 18% of the total area is coverd by water rendering the country greater potential for capture and aquaculture fish production.
- The country has five major lakes namely Victioria, Albert, Kyoga, George and Edward/ kazinga channel. The major rivers include:- Victoria Nile, Albert Nile and Kagera.
- The country is endowed with 160 minor lakes majority of which are in the west of the counrtry.

**Fish production-Capture fisheries:**

- The annual fish production by 2017 was at 456,000 tons, this declined from 836,255 tons in 2005 mainly due to:-

- Use of illegal fishing gears and methods.

- Population increase and corresponding demand for fish at local, regional and international level.
- Increased fishing effort

**Fish species:**

- The country has a diversity of over 360 fish species; however the commercial species are *Latesniloticus*, *oreochromisniloticus*, and *Rateneoboraargentea*(silver fish). Others include:- Bagrus, Clarisa, Protopterus, Alestes, Hydrocynus, Barbus e.t.c

**Fishing equipments and landing sites**

- The country has 834 gazzeted landing sites on all water bodies, 74 of which are on Lake Victioria.
- Planked canoes, dug out canoes are the common crafts used totaling to 175,335 of which 47% are motorised. The gudout canoes are commonly used on River Nile.
- Fishing gears include, gillnets, long lines, boat seine nets (silver fish) which are legally accepatable. The following are also used illegally, beach seines, cast nets, monofilament nets and traps.

**Aquaculture:**

- This is mainly done at subsistance level, but of recent commercial fish farming has started especially cages.
- The major systems of aquaculture include:
- Earthen ponds
- Tanks
- Cages
- The major species for aquaculture are,
- Tilapia (both *zilli* and *orochromis*)
- African cat fish (*Claria gariepinus*)
- Common carp (*Cyprinus carpio*)
- By 2017 there were over 20,000 ponds with an average surface area of 500 sq m and 3000 cages with a production of 111,000 tons
- Aquaculture development is hampered by;-
- Inadequate supply of quality seeds and feeds to farmers
- Inadequate extension services to support farmers
- Limited capital for investment especially cage farming.

**Fish marketing:**

- Fish is marketed either fresh, sun dried, salted, fried, smoked or frozen
- The major markets include:-
- Locally with in the country
- Regional i.e Kenya, Rwanda, South Sudan and Democratic Republic of Congo
- International mainly USA and Europe
- By 2005 the country had 16 fish processing factories, which have since reduced to 6 by 2016; these also operate at a low capacity. The government has set up strategies to reverse the trend through increased Monitoring Control and Survaillance of all water bodies to curb fishing malpractices.

- In 2017, 200 metric tons were exported to regional, USA and European market earning about 132 million US dollars making it the third foreign currency earner only after coffee and tourism.

**Employment:**

- It's estimated that 176,000 people are directly employed in fisheries, whereas 700,000 people derive their livelihood from fisheries related activities.

**Fisheries management:**

- Ministry of Agriculture Animal Industry and Fisheries
- Directotorate of Fisheries resources
- District Local governments
- Sub county Local government
- Beach ManagementUnits ( Landing sites)

- The spream law in fisheries management are:-

- The constitution that vests the management of all natural resources to the state
- The Fish Act Cap 197

**Institutions working in the fisheries sector:**

- National Fisheries Resource Research Insititute – NaFRRI ( capture Fisheries)
- National Aquaculture Research and Development Centre ( with regional centres)
- Lake Victoria Fisheries Organisation (LVFO)
- National Enviromental Management Authority
- Nile Basin Iniative
- Uganda National Bureau of standards ( Quality control)
- Food science and Technology Research Institute ( Quality control)

**Investment opportunities in the sector:**

- Manufacture of high fish value products (e.g fish caning)
- Dry/Smoked fish on a large scale- demand is high within the region.
- Marketing ornamental fish species
- Large scale aquaculture (Aqua parks)

FISHERY SECTOR IN ZIMBABWE

Taonashe Chitsika

***Location and Geography.***Zimbabwe is in central southern Africa. Because of the impact of its colonial history on the nations' political, economic, and sociocultural life, it generally is identified more with Southern Africa than with central Africa. A land-locked country of 242,700 square miles 390,580 square kilometres between the Zambezi River to the north and the Limpopo River to the south, it is bordered by Mozambique, South Africa, Botswana, Namibia, and Zambia. Most of the country is a high to middle veld plateau with extensive areas of wooded savanna and a temperate climate, the low veld of the Limpopo and the Zambezi Valley is hotter and has less rain. On the Mozambique border, the only mountainous area, the Eastern Highlands, runs from Nyanga in the north to Chimanimani in the south. Rainfall is higher in the north of the Eastern Highlands and lower in the Zambezi Valley and the low veld.

The 2018 population is estimated at 16.91 million, an increase from the 2013 estimate of 14.09 million, and the country ranks 71st in the world.The total surface of area of Zimbabwe is approximately 390,757 km². In combination with its relatively small size, it's also relatively sparsely populated with only 43.28 individuals per km².The population is relatively young, with 41 per cent aged below 15 and 4 per cent aged above 65.Agriculture, forestry and fishing sector employs the largest proportion of the population, at 67.2 per cent.

Zimbabwe has 17 official languages, Chewa, Chibarwe, English, Kalanga, "Koisan" (presumably Tsoa), Nambya, Ndau, Ndebele, Shangani, Shona, "sign language" (Zimbabwean sign languages), Sotho, Tonga, Tswana, Venda, and Xhosa. Much of the population speaks Bantu languages, such as Shona (chishona) (76%) and Ndebele (18%). Shona has a rich oral tradition. English is spoken primarily in the cities, but less so in rural areas. Education in Zimbabwe is taught in English, Shona and Ndebele. Many rural primary schools teach in the native language until grade three, then, school is taught in English.

Zimbabwe is named after Great Zimbabwe, the twelfth- to fifteenth-century stone-built capital of the Rozwi Shona dynasty. The name is thought to derive from*dzimbadzamabwe* "great stone houses" or*dzimbawaye* "esteemed houses". Cultural and religious traditions among the Shona, Ndebele and smaller groups of Tonga, Shangaan and Venda have similarities in regard to marriage practices and the belief in supernatural ancestors.Like in many African countries, a majority of Zimbabweans depend on staple foods, "Mealie meal", or cornmeal.

European culture and values indelibly shaped the urban and rural landscapes, particularly in terms of the use of space, and the structure and practice of government. Black Zimbabweans have assimilated more white Zimbabwean culture than vice versa. In these distinct cultures, which generally are referred to as African and European, the most obvious differences are economic, the white minority lost political power after independence

There are many types of food dishes and ways of preparing them; many types of songs and dances; a wide variety of marriage rites and ceremonies; many ways of establishing relations and social hierachies and their attendant obligationsZimbabwe is a landlocked country in southern Africa known for its dramatic landscape and diverse wildlife, much of it within parks, reserves and safari areas. On the Zambezi River, Victoria Falls make a thundering 108m drop into narrow Batoka Gorge, where there's white-water rafting and bungee-jumping. Downstream are Matusadona and Mana Pools national parks, home to hippos, rhinos and birdlife.

Zimbabwe's economy depends heavily on its mining and agriculture sectors.Agriculture has remained the mainstay of our economy since pre-colonial times. In fact, before colonialism, agriculture was the main economic activity. As Zimbabwe modernised and industrialised, agriculture became a key component of this modernisation and industrialisation process.Agriculture provides food for the population, raw materials for industry, employment for the people and is a source of foreign currency on account of exports. Prior to the fast-track land redistribution exercise of 2001, agriculture accounted for 41% of exports and it constituted about 18% of the country's GDP. A third of the population was engaged in agricultural activities in the 1990s.

The most important commercial fish stocks exploited by fishers in Zimbabwe are within five reservoirs namely Kariba, Chivero, Manyame, Mutirikwi and Mazvikadei. The largest fishery is on Lake Kariba (16o26´ to 18o06´S and 26o40´ to 29o03´E). It contributes almost 90 per cent of the country's fish production. Lake Kariba supports an open water semi-industrial fishery that exploits *Limnothrissamiodon* locally known as Kapenta and an artisanal inshore fishery restricted to the shallow inshore water where exploitation is through gillnets. Local people who live in villages around the lakeshore exploit the artisanal fishery.

The commercial fishery on Lake Chivero (17o54´S, 30o48´E, formerly Lake McIIwaine), a hyper-eutrophic lake that lies 37 km to the southwest of Harare utilizes seine nets in marginal shallow regions of the lake and gillnets in shallow to relatively deep waters. Commercial fishing also occurs on Lake Manyame formerly Darwendale dam which is located downstream of Lake Chivero near Norton, 76 km west of Harare. A gillnet fishery has been established on Mazvikadei dam, which is located on Mukwadzi River in Banket, northwest of Harare. Fishing on Lake Mutirikwi20o14´S, 31o00´E, formerly Lake Kyle, Zimbabwe's largest inland water-body, which lies southeast of the town of Masvingo, is based on gillnetting and seining. Commercial fishing commenced in 2002 on four recently constructed reservoirs namely Zhowe, Osborne, Muzhwi and Manyuchi while Manjirenji dam also supports a commercial gillnet fishery. In addition to that there is the largest inland dam Tokwe-Mukosi dam were fish stocking was done under command agriculture. Command agriculture is a government of Zimbabwe programme meant to boost agricultural production.

The fishery sector comprises of the capture fishery, aquaculture and recreational fishery. It exploits about 114 indigenous fish species and an additional 30 exotic species, which were introduced for aquaculture production. However only, the Nile Tilapia, *Oreochromisniloticus* has contributed significantly to fish production. Capture fisheries from Lake Kariba is the mainstay of the fishery sector, with a large aquaculture farm also on Lake Kariba contributing significantly to fish production.

The only fishery in Zimbabwe where systematic catch/effort data have been recorded and published annually until 2004 is Lake Kariba. Fish populations have also been monitored at Lake Chivero, Lake Mutirikwi and Manyame dam, otherwise it is difficult to obtain reliable fishery statistics and in most instances the total catch is unknown.

On Lake Kariba nine species comprising of cichlids (*Oreochromismortimeri*, *Oreochromisniloticus*, *Sargochromiscodringtonii*, *Tilapiarendalli*), cyprinid (*Labeo altivelis*), characid (*Hydrocynusvitattus*), mormyrids (*Mormyruslongirostris*, *Mormyropsanguilloides*) and a Clariid (*Clariasgariepinus*) are exploited commercially within the inshore fishery. An assessment in 2003 showed that *O. niloticus* is now the most important species in the total catch. Its relative importance in the total catch expressed as index of relative importance is 48 per cent among the cichlids while its proportion in the total catch is 37.1 per cent.LakeChivero's productivity is estimated to have reached 250 kg $h.^{-1}$ $yr^{-1}$. Annual production over the past ten years has varied from between 160 and 450 tonnes fresh weight. In 2000 the catch per unit effort as number of fish/setting/net for Clariidae, Cyprinidae, Mormyridae, Characidae and Cichlidae was estimated to be 1.28, 0.41, 0.24, 0.03 and 4.05 respectively. A total of twenty-nine species are exploited but two cichlids, *Oreochromismacrochir* and *Oreochromisniloticus* constitute more than 80 per cent of the total catch, with catch per unit effort of 1.03 and 2.76 respectively.

Annual production on Lake Mutirikwi is low varying between 14 - 20 tonnes while on Manyame production varies between 160 - 400 tonnes. Mazvikadei yields about 4 tonnes a year. There are no catch records for Manyuchi, Zhowe and Osborne. Species harvested in these reservoirs include *Oreochromismacrochir*, *Oreochromis mossambicus*, *Tilapia rendalli*, *Clariasgariepinus*, *Barbusmarequensis*, *Labeoaltivelis*, *Labeo congoro* and *Micropterussalmoides*, an exotic species.

The inshore fishery on Lake Kariba is exploited by approximately 1 272 fishers whose fishing gear comprises of 3 198 nets and 663 boats. The 663 boats are mostly dugout canoes. Only 0.8 per cent of the boats are motorised and these are used for speedy transportation of fish to markets. Currently there are 98 registered operators in the kapenta fishery on Lake Kariba who are fishing with 295 boats.

Post-harvesting processing for fish is limited and the infrastructure in place is minimal. Kapenta from Lake Kariba is either salted and sun-dried on drying racks or frozen. Most commercial artisanal fish catches are sold fresh/frozen, sun-dried or smoked. The only elaborate fish-processing infrastructure that comprises a state-of-the-art fish factory has been developed at the aquaculture farm in Kariba.

The artisanal fishers supply the local market. They sell their fish at landing sites to small-scale traders who after sun drying transport the fish to farms, towns and rural areas for marketing. Commercial operators supply fresh fish to retail shops in urban centres. Dried kapenta is sold locally in jute bags weighing 30 kg to traders and retail supermarkets where it is re-packaged into smaller units. *Oreochromisniloticus* produced from an aquaculture farm in Kariba is sold either locally or exported as frozen whole fish or fillets to the European market mainly supermarket chains across northern Europe and Spain and in the Southern Africa region. Factory by-products are sold from a factory gate shop. Trout is exported or sold locally as frozen trout, trout fillets, smoked trout and trout pates. Trout fish is mainly produced in Nyanga in the Eastern Highlands of the country because of prevailing temperatures there.

Zimbabwe has limited fisheries output despite the fact that the country has approximately 10 700 large to medium sized dams. Efforts have to be made to increase fish production in order to increase the country's per capita fish consumption.

Fish production does not rank among the most important contributors to GDP in the country. It is only important for food security as a protein source and for local employment and has a significant economic role at a local level. The output estimates in 2005 was 15 452 tonnes.

Fish demand exceeds supply in Zimbabwe. Due to increasing costs of other protein sources demand for Kapenta in urban and rural areas has increased. In 2004 an estimated 12 000 tonnes of fish was harvested from Lake Kariba. Annual fish production from all other capture fisheries is estimated to be about 870 tonnes. An estimated 20 tonnes of other fish was also harvested from fish farms throughout the country and approximately 2 400 tonnes from aquaculture in Lake Kariba. The estimated population in the country is 16.9 million thus the annual per capita fish consumption level is 1.2 kg, well below the SADC average of 6.7 kg.

Production from a fish farm on Lake Kariba and trout in the Eastern Highlands provide for the export market. Exports of fish in 2005 amounted to US$ 2.7 million. To date no much export is done except of a few private farms especially trout fish.

Tilapia purchases are made only by the relatively wealthy minority, being out of reach for the sector of the population with the greatest need. Most of the fish is sold in urban areas whereas 70 per cent of the population reside in rural areas. Its impact on household food security for the majority of the population is minimal. On Lake Kariba, significant impact is only on communities that live along the shoreline who have fish as an important part of their daily diet thereby curbing protein deficiencies. Otherwise high costs of fish production continually push the price of fish beyond the reach of many.

There are no consolidated national statistics on fisheries related employment, although generally both capture fishery and aquaculture are not significant employers at the national level. The estimated labour force in Zimbabwe is 3.94 million (2005 estimate) of which 66 per cent, 10 per cent and 24 per cent are employed in agriculture, industry and services respectively. At national level fisheries is not significantly contributing to employment. In Kariba approximately 3 000 people are employed in the kapenta fishery for catching, processing and packaging of fish. The artisanal fishery on Lake Kariba is exploited by 1 272 fishers. Lake Harvest Aquaculture farm employs about 320 workers while other water bodies have probably less than 100 people involved in fishing. An estimate of people involved in fisheries is approximately 4 700 for the whole country.

Fisheries development has not contributed much in the development of infrastructure or provision of services in rural areas or in fishing villages. The typical case is the Lake Kariba shoreline where there is a significant lack of development and service provision such that most of the shoreline area is inaccessible. Within the communities along Lake Kariba, infrastructure development and social service provision are poor, inadequate and sometimes non-existent. The other major reservoirs are located within parks estates (protected areas), and hence there are no rural communities surrounding them. Subsistence fishers from nearby urban and rural settlements commute daily to fish while commercial fishing companies operate from landing sites located along the shores. These basically house their fishing gear and a few employees on a temporary basis. Thus direct contribution of fishery to rural development is minimal.

The potential to boost fisheries production in Zimbabwe lies in utilizing the 10 001 dams that have been constructed for water storage. These reservoirs can be used for fish farming. Local communities capture existing fish stocks in these dams.

The capture fishery is threatened by increasing illegal fishing activities. Poachers encroach in areas set aside as breeding grounds for fish. Poaching introduces error margins in yield estimates, as the bulk of fish being caught is unaccounted for, thereby affecting management decisions.

The increase in occurrence of *O. niloticus* in the reservoirs can cause serious threats to indigenous cichlids through competition and crossbreeding. This species is known to crossbreed with two indigenous breams *O. mortimeri* and *O. mossambicus*. Inter-breeding will result in a reduction of the abundance of pure stocks resulting in loss of biodiversity.

The other constraint is inadequate extension and fishery information delivery services. Aquaculture production under natural conditions is restricted to the rainy season. It cannot be carried out in drought-prone areas and areas with temperature below 22$^{o}$C. Other constraints to aquaculture development include (i) inadequate fingerling supply due to the lack of well-managed hatcheries, (ii) limited extension infrastructures, (iii) lack of credit facilities for new fish farmers or fish farmers wanting to expand their facilities, (iv) marketing problems and (v) lack of quality feed.

The research institutions involved in fish related research and an indication of the activities they have been actively involved in are listed below.

| **Research institution** | **Main research projects** |
|---|---|
| University Lake Kariba Research Station (University of Zimbabwe) | Ecology of fish eating birds and their impact on the inshore fishery of Lake Kariba[P]<br>The ecology of *Sargochromiscondringtonii*[P]<br>*The inshore fish communities of Lake Kariba and aspects of their ecology*[O] |
| Lake Kariba Fisheries Research Institute (Zimbabwe Parks and Wildlife Management Authority) | Some management aspects of pre-recruitment ecology of the freshwater sardine *Limnothrissamiodon* in Lake Kariba[P]<br>The inshore fish population of Lake Kariba with reference to the biology of *Synodontiszambezensis* Peters, |

| | |
|---|---|
| | Hydroacoustic assessment of the Kapenta (*Limnothrissamiodon)* stock[P]<br>Bio-economic assessment of the Kapenta fishery on Lake Kariba |
| University of Zimbabwe, Department of Biological Sciences | Trophic interrelationships amongst cichlid fish species in a tropical African reservoir (Lake Chivero, Zimbabwe)[P]<br>The levels and bio concentration of heavy metals (Cu, Zn and Pb) in the African catfish *Clariasgariepinus* in streams around the City of Harare, Zimbabwe[P] |
| Lake Chivero Fisheries Research Station (Zimbabwe Parks and Wildlife Management Authority) | Fisheries Management Research[P] |
| Sebakwe Fisheries Research Station (Zimbabwe Parks and Wildlife Management Authority) | Fisheries Management Research[P] |
| Lake Mutirikwi Fisheries Research Station (Zimbabwe Parks and Wildlife Management Authority) | Fisheries Management Research[P] |
| Nyanga Trout Research Centre (Zimbabwe Parks and Wildlife Management Authority) | Trout Research, nutrition, diseases and trout propagation[P] |
| Matobo Fisheries Research Station (Zimbabwe Parks and Wildlife Management Authority) | Fisheries Management Research[P] |
| Henderson Research Station (Agricultural Research and Extension Services**,** Ministry of Lands, Agriculture and Rural Resettlement) | Aquaculture Research[P] |

P = past O = on-going

An externally funded project that was involved in assisting in the development of capture fisheries on Lake Kariba was the Zambia/Zimbabwe SADC Fisheries Project. The project was funded by NORAD (Norwegian Agency for Development) and DANIDA (Danish International Development Agency). An FAO/ALCOM Aquaculture Project has also been involved in promoting aquaculture among smallholder rural communities and equipping fish farmers with knowledge on fish stocking.

Currently there is limited foreign assistance in the fisheries sector as a result of the economic situation of the country. There are initiatives by the University Lake Kariba Research Station and the Lake Kariba Fisheries Research Institute to institute collaborative projects. A project entitled “An ecological and socio-economic assessment of biodiversity in a large tropical reservoir (Lake Kariba) towards the development of monitoring tools for conservation and sustainable utilization of freshwater resources in southern Africa” has been submitted to the Global Environmental Facility for consideration.

The African Wildlife Foundation and the Southern African Trust are involved in a project called “Piloting Community involvement in defining and applying SADC protocols for natural fisheries resources”. The project aims to promote community involvement in the development and implementation of SADC protocols for shared natural resources, with a particular focus on shared fisheries resources. The main objectives of the project are to do a participatory analysis of existing community resource-monitoring systems (CRMS) and legal frameworks for shared fisheries resources, to develop, discuss and adopt a CRMS protocol for shared fisheries resources along the Zambezi River basin and to disseminate information on the CRMS protocol and participatory process.

The Zimbabwe Parks and Wildlife Management Authority is empowered, through its Director to regulate, control, restrict or prohibit fishing in controlled waters. The Parks and Wildlife Management Authority has overall responsibility for fisheries development throughout the country. Its responsibility within the Parks Estates includes research and management. It has sole authority for the management of the fishery resources in Kariba,Tokwe-Mukosi,Chivero, Mutirikwi, Manyame and Sebakwe. Management, control and fisheries research is effected through personnel stationed at research stations located at these dams.

Fisheries management regulations are enacted within the National Parks Act of 1975 (Parks and Wildlife Act–Chapter 20:14 of 1996, as amended. This is the principal legislation and management Act governing the development, control and management of fisheries in Zimbabwe. Part XIV of the Act deals with fish conservation. The regulations focus on licence limitation, gear and area restriction and controlling mesh size and number of nets allowed per fisher in order to regulate effort.

The overall management strategy for fisheries resources in Zimbabwe is sustainable utilization and maintenance of biological diversity. The overall aim is to increase production in order to strengthen the rural economy, create employment and enhance household food security.

**Institutional arrangements**

*Co-management activities*

An initiative to introduce fishery co-management within the inshore fishery has been implemented on Lake Kariba. The objective is to reduce conflicts between fishers and resource managers by bringing in fishers’ participatory management. Provisions of co-management are in (a) a legal framework – section 95(1) of the National Parks Act of 1991 and 1994 (SI 12/91 and SI 40/94 respectively) which allow for devolution of appropriate authority to district councils who then sublease exclusive fishing zones to local fishing communities. Through the provision of a Kariba Lakeshore Combination Master Plan the fishing grounds were zoned and assigned to specific fisher groups. Fishers were assisted to establish fisheries management institutions, to formulate constitutions and were trained in necessary skills. The success of the co-management initiative on Lake Kariba has not yet been evaluated. It is anticipated that if the system is effective it may be introduced on other reservoirs.

*Participatory approaches*

Fishery management in Zimbabwe is guided through the provisions of the Parks and Wildlife Act. A fisheries policy that embodies participatory approaches has not yet been formulated. As such there is limited involvement and participation by communities and stakeholders in fisheries management. It is the sole responsibility of the Parks and Wildlife Management Authority to manage the fishery resources. This causes conflicts of interests among fishers and resource managers. Enabling policies and legislation that involve fishers in a participatory management process are still to be instituted.

Appropriate management measures have been instituted on each fishery as provided for by the Act. Fishing within the Kapenta fishery on Lake Kariba occurs year-round. The fishery is managed through enforcement of regulations. The fishing effort is controlled through provision of licences. Recruitment and growth over-fishing is reduced by restricting the minimum mesh size to 8 mm. Pre-recruits occur in water less than 20 m deep so fishing is confined to areas more than 20 m deep. Fishing is prohibited within a 2-km radius of all river mouths in order to protect species on spawning runs up the rivers.

The regulations used for management of the inshore fishery in Lake Kariba are intended to ensure the conservation of biodiversity while allowing for sustainable utilization of the fishery resource. Since the lake is a recreation park it is also intended that the amenity value of the lake be maintained. This is effected through licensing, gear restrictions and closed areas. Fishers have to obtain an annual licence and are allowed to fish in designated fishing grounds within the lake that have been delimited for specific villages. Fishing is not allowed in closed and protected reserves, which include rivers, river mouths and the shoreline adjacent to national parks and wildlife land. On Lake Kariba approximately 600 km of shoreline is closed to fishing. Closed and protected reserves have been left aside in order to enhance recruitment, protect potamodromous species, protect breeding areas and conserve fish stocks that become reservoirs for replenishing neighbouring fished areas and to maintain biodiversity for the long term.

On Lake Kariba, the minimum gillnet mesh size (stretched) allowed in commercial inshore fishing areas is approximately 102 mm (4 inches). Each fisher is allowed five gillnets of 90 m length each (unmounted). The use of explosives, chemicals, poisons, intoxicating substances, scoop nets, jigging and fish-driving are prohibited. Commercial fishing using spear guns, basket traps and rod-and-lines with 3 hooks or more is prohibited. There is a bag limit for recreational fishing (e.g. rod and line and spear fishing).

On the other reservoirs fishers are issued licences, which are renewable annually. The licence specifies the dimensions of the nets, their mesh size and the reservoir where they can be used. On Lake Mutirikwi and Nyanga reservoirs, bag limits are used to control angling for bass and trout. Use of gillnets is not allowed in the rivers and their use in reservoirs is subject to a number of restrictions.

Recreational fishery is carried-out in most of the reservoirs. Anglers are not regulated closely except for the issuance of licences for fishing in reservoirs within park estates or for trout fishing in the Eastern Highlands. There are no statistics on the number of angler-days in reservoirs and catch data. Lake Chivero where recreational fishery is most productive has an estimated production of 120 kg/ha of which 49 per cent is from the commercial fishery, 27 per cent from recreational anglers and 24 per cent from subsistence anglers.

Sport fishing for trout is carried out in reservoirs and rivers in Nyanga National Park in the Eastern Highlands while that for Large Mouth Bass (*Micropterussalmoides*) is carried out on Mutirikwi, Manyuchi, Manjirenji, Matopos, Ncema and Mayfair dams. Sport fishing for tiger fish (*Hydrocynusvittatus*) is also done in the Zambezi River and its tributaries. Subsistence angling is a common activity in all reservoirs near urban centres mainly Lake Chivero, Lake Manyame and Lake Kariba. Generally the intensity of the fishery is influenced by the size of the local urban population, demand from tourism and accessibility of the water body. The fishing gear used is rod-and-line.

Major events of the recreational fishery include the Annual International Tigerfish Tournament held on Kariba and the Bass Masters Tournament that is held on Lake Manyame. The International Tigerfish Tournament is the biggest sport-fishing event in Zimbabwe. Recreational fishing is presently not included in the general management programmes making it difficult to estimate its contributory role to fish production.

Aquaculture production is carried out for subsistence and commercial purposes. Subsistence aquaculture is carried out at household level. It is limited to a few pond-based enterprises where it provides a cheap source of protein for domestic consumption. Indigenous species such as Mozambique Tilapia (*Oreochromismossambicus*), the Red-Breasted Tilapia (*Tilapia rendalii*), the Green-Headed Tilapia (*Oreochromismacrochir*), the Kariba Bream (*Oreochromismortimeri*) and Sharptooth Catfish (*Clariasgariepinus*) are utilized. Annual production from subsistence aquaculture is estimated to be 900 tonnes.

Commercial aquaculture production is based on the Nile tilapia, (*Oreochromisniloticus*) and the rainbow trout (*Onycorhynchus mykiss*). Commercial aquaculture production is estimated to produce approximately 1 600 tons per annum mainly from a farm on Lake Kariba. The farm was established by Lake Harvest Aquaculture (Pvt) Ltd in 1997. It grows Nile Tilapia, which contributes more than 80 per cent of the annual production from aquaculture. The production system uses small-dammed reservoirs (about 1.5 m deep) for breeding fish until they weigh about 20 - 25 grams, after which they are transferred to floating net cages suspended in Lake Kariba where they grow-out to a market size of about 900 g. The cages produce 50 kg of tilapia per $m^3$.

Trout production is confined to the high-altitude Eastern Highlands where temperatures are cooler and the water quality is good. The species cultured are Rainbow Trout (*Oncorhynchus mykiss*) and Brown Trout (*Salmo trutta*).

The Parks and Wildlife Act provides the regulations for aquaculture management in Zimbabwe while the Parks and Wildlife Management Authority grants authority for development of aquaculture on state dams and in water designated as Recreational Park.

Four formalised institutions have been formed through the initiatives of the co-management approach in the gill-net fishery on Lake Kariba. District Fishing

Associations (DIFA) are responsible for coordination of fishing activities at district level while Sub-Area Fishers Associations (SAFAs) comprising of 4-6 adjacent fishing villages are responsible for effecting dialogue among members and between fishers and the state. Within each SAFA is a Fisheries Management Committee and 3 resource monitors. The Kapenta operators on Lake Kariba have representation through two Kapenta fishing associations.

**End**