Feed The Future India Triangular Training Programme (FTF-ITT)

Recent trends in Harvest and Post-Harvest Technologies in Fisheries

September 12-26,2017

FINAL REPORT

भाकृअनुप - केन्द्रीय मात्स्यिकी प्रौद्योगिकी संस्थान

ICAR - CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY

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(ISO/IEC 17025: 2005 Accredited & ISO 9001: 2008 Certified)

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Feed The Future India Triangular Training (FTF ITT) Program

on

Recent trends in Harvest and Post-Harvest Fishery Technologies

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Foreword

ICAR-Central Institute of Fisheries Technology was established as Central Fisheries Technological Research Station CFTRS on 29th April 1957 and recently completed 70 years of existence with thundering Diamond Jubilee Celebrations. Building a scientific institution requires decades of dedication of not by one individual but of a strong team with indomitable altruistic spirit that is basis for strong foundations. In CIFT there is no dearth for that team spirit as evidenced by all walks of scientific progress from harvest to post harvest fisheries in terms of outstanding research, disseminating in different fora at national and international level. Knowledge gaining requires extremes of endeavours but more important is spreading the same to different levels to pragmatise makes it more fruitful. In this regard the present international training programme under Feed The Future India Triangular Training (FTF ITT) Program on '**Recent trends in Harvest and Post-Harvest Technologies in Fisheries**' being held from 12-26 September,2017 one more test to see how far the team spirit of CIFT can stretch to meet demands at global level. This programme is being organised as a result of new agriculture partnership between US and India to address Global Food Security as a part of FTF-ITT under the joint initiative of Indo-US collaboration funded by USAID, India and coordinated by MANAGE, Hyderabad is great opportunity for the CIFT team. I am sure they come out with flying colours. The manual contain more than 40 chapters covering all aspects of harvest and post-harvest fisheries by experts in the field with decades of pragmatic experience. On behalf of CIFT I welcome our international executive guests from Afghanistan, Afghanistan, Ghana, Kenya, Liberia, Malawi, Mongolia, Sudan and Uganda to the program with a wish they become brand ambassadors in taking forward the knowledge gained to respective countries to fill the much needed gap of food, nutritional security and socioeconomic essentials of millions through harvest and post-harvest fisheries.

C.N. Ravishankar
Director, ICAR-CIFT

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1. Introduction

1.1. Background

Fisheries make critical contributions for the food and nutritional security of over 41 million people worldwide, the vast majority of whom live in developing countries, out of which India alone shares more than 1/3rd of global figure. Fish is not only an important source of nutrients for the poor and often being the cheapest form of animal protein, but it plays an important role in livelihood development through large scale employment opportunities destined with a wide scope for export trade. Better fish harvest technologies facilitate conservation and sustainable fishing; while post harvest technologies help in income generation, entrepreneurial prospect leading to betterment of the livelihood standards of populations. The present course was proposed considering the vital importance of human resource development and capacity building in fish harvesting and post harvest technologies for effective development of fishery sector in African and Asian countries.

1.2. ICAR- Central Institute of Fisheries Technology

ICAR-Central Institute of Fisheries Technology (CIFT), a pioneer research institute under the aegis of Indian Council of Agricultural Research (ICAR) has been playing a pivotal role in pursuing its research and extension activities in harvesting and post harvesting sectors in fisheries during its fruitful existence since last six decades. Since its inception during 29th April, 1957; the institute has been instrumental in modernizing the fishing and fish processing sectors in the country and continues to impart technological support to a broad spectrum of stakeholders comprising of fisher folk, students, extension professionals, seafood industries, fish entrepreneurs, faculties and scientists through well designed skill oriented training programmes.

The major activities of the institute centers around evolving innovative and cost effective technologies for fish harvesting, development and standardization of different post harvest practices, techniques for extraction of biomedical, pharmaceutical and industrial product from aquatic organisms, biotechnological approaches for disease diagnostic tools; quality management and maintaining food safety standards; design and development of tools and techniques for harvesting and storage and at the end transferring the technologies to end users through training, education and extension programmes with the involvement of highly qualified and experienced faculty scientists from seven different divisions *viz.*,

Fishing Technology, Fish Processing, Quality Assurance and Management, Microbiology, Fermentation and Biotechnology, Engineering and Extension, Information and Statistics Division.

The institute functions with the following mandates:

- Basic and strategic research in fishing and processing.
- Design and develop energy efficient fishing systems for responsible fishing and sustainable management
- Development of implements and machinery for fishing and fish processing.
- Human resource Development through training, education and extension.

On the human resource development front, the Institute continues to offer its premier technical expertise and advice in the areas of fishing, fish processing, quality management, food safety, nuetraceuticals development etc. on a continuously evolving basis. The Institute offers regular, comprehensive, specialized and certificate training programmes on responsible fishing, fish processing, value addition, and packaging and quality control systems for the benefit of researchers, prospective entrepreneurs, industry personnel, extension professional, students alike and also International training programmes under TCS of Colombo plan and SAARC regional training programmes.

The infrastructural facilities at CIFT include NABL accredited laboratories, National level referral food laboratory, craft and gear laboratory, research vessels, Pilot processing plant for value added fish products development, Engineering Workshop, ATIC and well equipped AV aided class rooms. The Institute also has an Agri-Business Incubation Centre to promote business incubation activities and start-up ventures in post-harvest fishery technologies. With this backdrop, the ICAR-CIFT conducted a training programme under **Feed The Future India Triangular Training (FTF ITT) Program** *on 'Recent trends in Harvest and Post-Harvest Technologies in Fishery'.*

1.3. Key Focus areas of the training module

The training programme was designed in consultation with all divisions of CIFT and Manage by integrating interactive lectures, hands-on experiences an field visits

interlaced with cross cultural experiences. The training course emphasized on recent trends in fish harvest and post-harvest technological developments suitable for African and Asian countries, with focus on following aspects:

- Innovative and cost effective technologies for fish harvesting, responsible fishing
- Development and standardization of different post harvest practices, value addition, and packaging
- Techniques for extraction of biomedical, pharmaceutical and industrial product from aquatic organisms,
- Biotechnological approaches for disease diagnostic tools
- Quality control, management and maintaining food safety standards
- Design and development of tools and techniques for harvesting and storage of fishes
- Effective extension methodologies, value chain management and entrepreneurship development in fishery

The FTF-ITT Programme Brochure

Originally the training was conceptualized devoting about 30% time on lecture-cum-interaction sessions, 40% time on hands on practical on selected technologies, 30%time for field visits to villages, landing centers, processing plants, and meeting other relevant stakeholders. However, after initial feedback from trainees, changes

were made in the schedule accommodating more than 50 percent time for practical hands on sessions.

1.4 Technologies covered under the training

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.

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 codends 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 months 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 aquaculture 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 LOA 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.

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 unfavorable 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

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, neutraceutical 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 technology 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 CO2 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., O2, CO2, odour, ethylene), releasing system (e.g., N2, CO2, 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 O2 scavenging, CO_2emitters, 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) is 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

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.

Surimi and surimi-based products:

Surimi, washed mince added with cryo-protectants, 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.

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, Tapioca and fish curry, Seerfish Moli, mussel/oystermasala 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. 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 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.

High value byproducts

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 has 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 standardized 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 14th 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 optimized. 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.

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.

2. The Participants

2.1. Selection of Executives

The programme was formally announced by the National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India. The Programme Management Unit (PMU), FTF-ITT, at MANAGE has prepared the programme brochure initiated the process and provided good publicity in partner countries through their Point of Contact (POC), Indian Embassies, USAID Missions of respective countries, National Governments and previously trained Executives. The partner country agriculture and allied departments have nominated the executives and the PMU-FTF ITT of MANAGE has finalized the nominations.

2.2. Profile of the Executives

This unique programme was attended by 22 executives representing six African and two Asian countries representing a wide range of cultural diversity. The profile of trainees was as follows:

S.No.	Name & Address
	Afghanistan
1.	**Dr. Hamdard Bahadar Khan** Provincial Veterinary Epidemiology Officer Mandakol Road, Asadabad, Directorate Agriculture Irrigation and Livestock, Kunar Province, Afghanistan
2.	**Mr. Frogh Khalilullah** Director Department of Fisheries, Darula Aman Road, Sanatorium Street, General Directorate of Animal Health and Protection, Kabul, Afghanistan
3.	**Mr. Abdulhadi Babury** Livestock Specialist

	Nangarhar Agriculture Irrigation and Livestock Directorate Address: Nangarhar Province , Baburyan Village,Jalalabad City, Afghanistan
4.	**Mr. Rokhan Zalmai** Technical Advisor and Secretary for GDE MAIL, General Directorate of Extension Jamal Maina, Karti Sakhay Square Kabul, Afghanistan
	Ghana
5.	**Mr. Anthony Appiah** Senior Fisheries Officer P.O.Box 140, Winneba- Central Region Ghana
6.	**Ms. Janet Anchirinah** Assistant Director of Fisheries Fisheries Commission, P.O.Box AK138 Akosombo, Ghana.
7.	**Mrs. Neils Palme Ruby** Deputy Director Ministry of Food and Agriculture-Monitoring and Evaluation Directorate C/o Ministry of Food and Agriculture, P.O. Box: M37, Ministries, ACCRA Ghana
8.	**Ms. Fuseina Issah** Assistant Fisheries Officer Fisheries Commission (Administration and Operations Department-Monitoring and Evaluation) Box GP 630 Accra- Ghana
	Kenya
9.	**Mr. Japhet Mworia Manampiu** Assistant Director of Fisheries State Department for fisheries and Blue Economy Ministry of Agriculture, Livestock and Fisheries. P.O. Box. 1200-00100 Meru, Kenya
	Liberia
10.	**Mr. Alfred David** Agriculturist Ministry of Agriculture,

	P.O.Box 10-9010 1000 Monrovia 10, Liberia
11.	**Ms. Beatrice Kuesh Newland** Quality Assurance Technician Ministry of Agriculture Bureau of National - Monrovia, Liberia
12.	**Mr. Peter M. Sesay** Technician Ministry of Agriculture, P.O.Box 10-9010 1000 Monrovia 10, Liberia
13.	**Mr. Victor F. Nah** Fisheries Quality Assurance Technician Department of Technical Services Bureau of National Fisheries/ Ministry of Agriculture Liberia
14.	**Mr. Joseph Manjoe Sovie** Agricultural Extension Technician Smallholder Agricultural Productivity Enhancement and Commercialization Project (SAPEC) Ministry of Agriculture South Cooperation, Liberia
	Malawi
15.	**Mr. Mbalaka Mwamad Salim** Fisheries Research Officer, Department of Fisheries, Monkey Bay Fisheries Research Station, P.O.Box.27, Monkey Bay, Mongochi, Malawi
16.	**Mr. Letson Yoyola Phiri** Principal Fisheries Officer Malawi College of Fisheries, Private Bag 7, Mangochi, Malawi
	Mongolia
17.	**Mr. Munkhbaatar Gyalbaa** Specialist of Livestock Conservation Fund Ministry of Food, Agriculture and Light Industry of Mongolia Government House 9A, Peace Avenue 16A, Bayanzurkh District, Vlaunbaatar, Mongolia
	Sudan
18.	**Mr. Arafat Abdelrahman Dahab Hagar** Fisheries Officer

	Ministry of Animal Resources, P.O.Box 293, Khartoum Directorate of Fisheries General, Sudan
19.	**Mr. Khider Shakheldeen Ahmeh Jamaleldeen** Fisheries Officer Ministry of Animal Resources, P.O.Box 293, Khartoum Directorate of Fisheries General Sudan
20.	**Ms. Nasma Abdelbagi Altegani Abubaker** Fisheries Officer Ministry of Animal Resources, P.O.Box 293, Khartoum Directorate of Fisheries General, Sudan
	Uganda
21.	**Mr. Kitamirike Joseph Blender** Fisheries Officer ARUA District Local Government, Department of Production and Marketing, P.O.Box. 1, ARUA, Uganda
22.	**Mr. David Nsamba Nsole** Principal Fisheries Officer/ District Fisheries Officer Nakasongola District Local Government P.O.Box 1, Nakasongola, Uganda

Group photo of trainees

3. Inauguration of the Programme

The programme was inaugurated on 13-09-2017 by Dr. P. Rajendran, Vice Chancellor, Kerala Agricultural university. While inaugurating the training programme he opined that 'Unless the information and technologies developed in fisheries sector is transferred to needy people across the globe, the entire process of knowledge generation will remain futile'. he highlighted that scope for growth in crop sector is almost achieved, but there exists tremendous potential for growth in fisheries and livestock sector. Fisheries is important sector as far as the economies of Kerala and India are considered. It contributes to 1% of total GDP of India supporting the livelihood security of more than 15 million people in the countrydirectly and indirectly. With an estimated 12 fold increase in export earnings from fishery sector during the last two decades, it need to be given proper attention forcreating employment generation opportunities.

Inauguration of the programme

Dr.C.N.Ravishankar, Director, ICAR-CIFT highlighted the role of CIFT in promoting application based research in harvest and post-harvest fisheries sector during the presidential address. Dr. Ravi Nandi, Programme Manager at MANAGE, Hyderabad briefed about the genesis of FTT-ITT programme. He told the programme was announced during the visit of then U.S. President, Mr. Barak Obama to India in November 2010. The intention is to utilize the institutional and technological strength of India in the field of agricultural and allied areas for achieving global food security. Dr.A.K. Mohanty, Head, Extension, Information and Statistics division gave an overview of the training programme at CIFT. Dr.Susheela Mathew, Head, Biochemistry and Nutrition Division gave the welcome address and Dr. Ashok Kumar, Head, Fish Processing division offered vote of thanks.

4. Learning Methodology

Using the principles of human learning, the FTF training was delivered in a participatory mode through a combination of interactive lectures, discussions, practical sessions and field visits. During the discussions, the participants were involved at every stage and presented pertinent information on the field problems specific to their countries. The practical sessions were imparted through Hands-On experiential learning.

Director, CIFT welcoming delegates

Ice-breaking session

Originally the training was conceptualized devoting about 30% time on lecture-cum-interaction sessions, 40% time on hands on practical on selected technologies, 30% time for field visits to villages, landing centers, processing plants, and meeting other relevant stakeholders. However after initial feedback from trainees, changes were made in the schedule accommodating more than 50 percent time for practical hands on sessions.

4.1 Interactive and hands on sessions

The executives were provided more than 40 interactive and hands on sessions on various aspects of fish harvest, processing and value addition technologies.The training covered all important aspects of harvest and post harvest technologies in fisheries including important topics like: Importance of responsible fishing, Recent trends in fishing gear materials, Design and operation of trawls, By-catch reduction devices in trawling, Nano application in material protection, Energy saving in fishing vessels and Craft and gear material testing under Fishing Technology.

Dr. Ravi Nandi, Manage addressing trainees

Dr. A.K. Mohanty, FTF-ITT Coordinator introducing the course

Under Fish Processing topics like Handling and chilled storage, Low temperature preservation of fish products, Thermal processing of Fish, Smoking of Fishes, Value added fish products, Extruded fish products, Non-thermal processing of fishes, Vacuum packaging & MAP, Seafood packaging, Utilization of secondary raw material from fish and Utilization of fishery waste.

Visit to various labs at CIFT

Major topics under Quality assurance and management, Nuetraceuticals, biochemical analysis, microencapsulation, innovations in fishery engineering, microbiological aspects and innovations in transfer of technology and fishery economics were also covered during the programme.

A hands-on session in progress

A demo session in progress

The lectures weredelivered in an interactive mode through inquiry approach to stimulate the thought processamong the participants. All classes were visually enriched and focused on stimulating multi-modal learning to enhance learning and retention. Each session was followed by question and answer sessions where the participants were allowed freely to interact with the faculty. Feedback sessions were conducted daily wherein selected trainee will present a concise report of lectures and activities that happened on previous day.

A practical session in progress

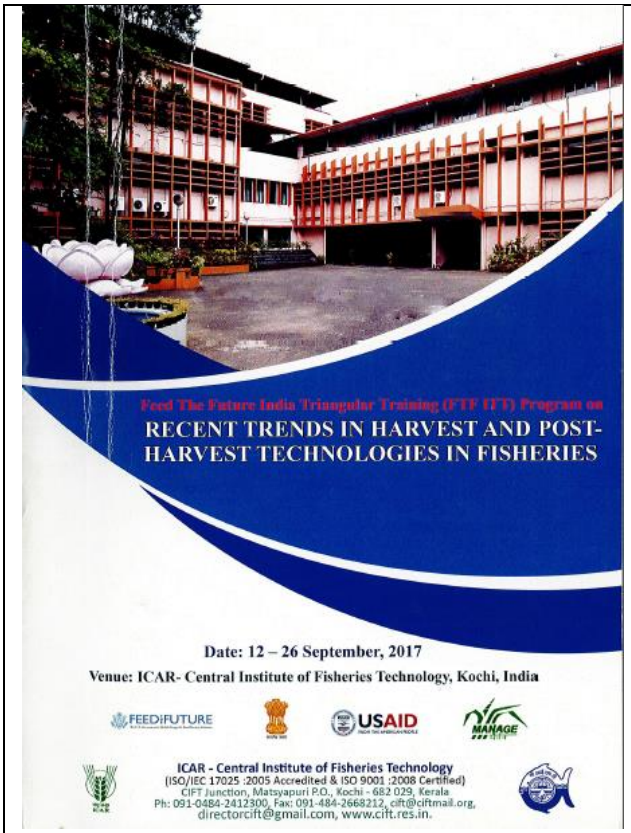
A hands-on session in progress

An interactive session in progress

A feedback session in progress

4.2 Course Material

The participants were provided with both hard and soft copies of all the presentations of theFTF-ITT well in advance for continues reading and clarifying doubts.



Cover page and inner page of Training manual provided

The executives were provided full access to ICAR-CTCRI library - books, journals, newsletters,reports, technical bulletins etc. Besides they were provided Wi-Fi which enabled them toaccess to digital library of ICAR to browse and download papers from current and archivedjournals and magazines.

Along with the study materials, the executives were provided various support literatureincluding brochure and leaflets, booklets, technical bulletins, class notes, video clips etc onimproved tuber crops technologies to strengthen learning.

4.3 Resource Persons

Since ICAR-CIFT is the only Institute conducting research exclusively on fish harvest and processing technologies in India, the resource persons were largely drawn from CIFT scientists. Few external resource persons were invited for handling sessions like food safety standards, ornamental fisheries, fish genetic resources, inland fisheries, aquaculture etc.

Sessions by invited experts

4.4 Visit to research and development organizations

The trainees were also taken for field visits covering major research and development organizations in Kerala.V. Chandrasekar (Scientist) & K.D Jose (Technical Officer) from ICAR-CIFT handled the African participants' visit to institutes such as NIFPHATT, MATSYAFED Net making factory, ICAR-CMFRI. ICAR-CIFRI (Kochi Centre) &ICAR-NBFGRI (Kochi center).

1. At National Institute of Fisheries and Post-Harvest Technology and Training (NIFPHATT) Kochi, after the brief introduction about Institute by the Director, the

trainees were taken to processing plant. Theywere explained the different process of value added product development from several varieties of fishes including low value, unconventional species and seasonally abundant fishes. Further the trainees were shown the different post-harvest technologies, refrigeration technology, Quality control and value added products in the processing plant.

2. The visit to Matsyafed Net making factory at Kochi was useful for the trainees to get acquainted about fishing net making machine. The factory has capacity to produce all kinds of fish net like gillnets, purse seine nets and trawl nets of all sizes.Net was made up of nylon multifilament, polyethylene net of different mesh sizes. Further a detailed explanation was given by manager of net making factory about the existing fishermen Co-operative structure in Kerala and how it is beneficial to member fishers.
3. During the Visit to ICAR-Central Marine Fisheries Research Institute, Kochi, Dr. Imelda Joseph, Principal Scientist & Head in Charge, Mariculture Division gave lecture on Mariculture technologies about mussel farming, Pearl culture, sea weed farming, prawn breeding, breeding and seed production of cobia, pompano and grouper, cage culture, ornamental fish breeding & Human resource development
4. During the visit to ICAR-Central Inland Fisheries Research Institute, Dr. Rani Palaniswamy, Principal Scientist, ICAR-CIFRI, Kochi center sensitized the trainees on food and nutritional security from inland fisheries, explained about the fish nursery rearing in cages, fish seed production, harvest and different gears used for the operation and finally explained the cost and benefit of inland fish farming.
5. At ICAR-National Bureau of Fish Genetic Resources, Kochi center,Dr. V.S. Basheer, PMFGR centre, Kochi explained about Fish Genetic Resources and its conservation and covered topics such as Global and Indian diversity -major fish genetic resources, fish genetic resources, Fish diversity in coldwaters, Ichthyo-diversity in brackish water, Commercially-important Shellfishes and native ornamental fish diversity of India.

5. Extra-curricular activities

5.1 Visit to places of tourist importance

Visiting tourist spots is an essential component of any trainingprogramme of international importance. The travel to places is not only refreshing the mindsand

body of executives, but also releases a vast amount of mental pressureaccumulated through intensive learning process.


Trainees enjoying houseboat ride at Kumarakom


Trainees during Munnar visit

As a part FTF ITT, the executivesvisited the following places:

1. Back waters of Kumarakom
2. Athirappilly Waterfalls
3. Tea gardens of Munnar
4. Fort Kochi and Jew Street, Mattancherry
5. Lulu Mall (India's largest Mall)

5.2 Cultural Evening

The cultural evening is an event where the people from diverse culture perform and displaythe unique aspects of their traditional art forms. Considering the importance of culturaldisplay, a cultural evening was arranged. Performances from various countries were made by the trainees which enthralled the audience.






Glimpses from cultural night

5.3 Kalaripayattu show

Considered among the oldest and most scientific martial arts in the world, Kalaripayattu was developed in Kerala. Lauded as the pride of Kerala, it is acknowledged and respected across the world. The training begins with an oil massage of the entire body until it is agile and supple.


Trainees enjoying Kalaripayattu Show

The FTF-ITT trainees were enthralled to witness a grand Kalaripayattu show hosted by ICAR-CIFT.Feats like chattom (jumping), ottam (running) and marichil (somersault) were demonstrated along with lessons in using weapons like swords, daggers, spears, maces, and bows and arrows. The CIFT staff also presented a 'Mohiniyattom' dance event for the benefit of trainees.


Mohiniyattom performance by CIFT staff for FTF-ITT trainees

6. Back At Work Plans

The Back At Work is a component of the FTF ITT which ensures the effective transfer of learning by the executives after they return to their respective countries. The FTF ITT Tuber was organized to improve their knowledge and sharpen skills for the purpose of implementing the new learning on tuber crops for improving the livelihoods of people at African partner countries. This process will be executed, monitored for a period of six months after the training programme. Considering these aspects, the executives were requested to prepared their Back-At-Work plan based on following guidelines:

- The Back At Work plan should be prepared to meet the immediate development objectives of their countries
- The plan should focus on aspects which are essential and easily implemented without demanding huge financial investments
- The focus will be on soft skills including knowledge as the materials technologies can't be transferred immediately as they require clearances form various departments.
- Each plan should have monitorable targets and achievable objectives.

Presentation of BAWP by trainees

In the long term, these plans should develop functional linkages between India and respective African countries to enable (i) technology and material transfer, (ii) offering consultancies, (iii) conducting contract research etc. Such linkages will help to establish collaborative co-construction of knowledge and materials for sustaining the benefits of collaboration for longer periods.The presentations of back to work projects based on identification of technologies suitable for respective countries were also successfully completed with major CIFT technologies like Silage from fish waste, handling and chilled storage of fish, smoked fish and fish de-scaler being the most widely taken up technologies by trainees for popularisation.The individual back at Work Plans presented by executives were as follows:

Sl. No.	Name of trainee	BAWP presented
1.	Dr. Hamdard Bahadar Khan	Public awareness program on fish processing at Kunar Province of Afghanisthan

2.	Mr. Frogh Khalilullah	Public awareness program on fish processing at Kunar Province of Afghanisthan
3.	Dr. Abdul Hadi Baburi	Public awareness program on fish processing at Kunar Province of Afghanisthan
4.	Mr. Rokhan Zalmai	Aquaculture to increase fish production at Kunar Province of Afghanisthan
5.	Mr. Anthony Appiah	Production of Fish Silage in the Central Region of Ghana
6.	Ms. Janet Anchirinah	Production of Silage from Tilapia waste in the Central Region of Ghana
7.	Mrs. Neils Palme Ruby	Hygienic fish handling practices on board in the Central Region of Ghana
8.	Ms. Fuseina Issah	Production of Silage from Tilapia waste in the Central Region of Ghana
9.	Mr. Japhet Mworia Manampiu	Production of Fish Silage
10.	Mr. Alfred David	Fish smoking techniques at Paynesville, Monrovia, Liberia
11.	Ms. Beatrice Newland	Chilling and handling of fish at West Point Beach, Liberia
12.	Mr. Peter M. Sesay	Gender Mainstreaming activities in grand Cape-mouth county and Bomi County, Liberia.
13.	Mr. Victor F. Nah	Chilling and handling of fish among Banjour community, Liberia.
14.	Mr. Joseph Manjoe Sovie	Improved Transfer of Technology methods in Maryland County, Liberia

15.	Mr. Mbalaka Mwamad Salim	Popularisation of CIFT Fish de-scaling machine at Mangochi, Malawi
16.	Mr. Letson Yoyola Phiri	Popularisation of CIFT Fish de-scaling machine at Mangochi, Malawi
17.	Mr. Munkhbaatar Gyalbaa	Popularisation of CIFT modified fish nets in Mongolia
18.	Mr. Arafat Abdelrahman Dahab Hagar	Ornamental Fisheries for income generation at Khartoum, Sudan
19.	Mr. Khider Shakeldeen Ahmed Jamaleldeen	Popularisation of modified fishing gears at Khartoum, Sudan
20.	Ms. Nasma Abdelbagi Altegani Abubaker	Popularisation of Fish drying techniques at Khartoum, Sudan
21.	Mr. Kitamirike Joseph Blender	Low temperature preservation of fish
22.	Mr. Nsamba David Nsole	Advanced fishing techniques and fish processing activities

7. Evaluation of training

Evaluation is an essential component of the training process, which helps to understand its effectiveness in terms of achieving training objectives and meeting the needs of the participants. In general, evaluation is the collection, analysis and interpretation of information about any aspect of a program of education or training as part of a recognized process of judging its effectiveness, its efficiency and any other outcomes it may have. Evaluation is often considered as taking place at four different levels:

1. Reaction: What does the learner feel about the training? – Collected through oral/written feed-back, open ended questions/close ended questions.
2. Learning: What facts, knowledge and experiences did the learner gain? – Estimated through knowledge tests (knowledge gain), observation. etc.
3. Behaviours: What skills did the learner develop and what new information can the learner use on the job? – Collected through observation

4. Results or effectiveness: What results occurred? Did the learner apply the new skills to the necessary tasks and what results were achieved? – Assessed through implementation reports of Back At Work plans

The pre and post test scores indicated a significant increase in knowledge of the trainees with majority of the trainees reporting upto 30 percent increase in knowledge after training.

8. Valedictory and Closing ceremony

Shri. Sanjay Dawe, Member, Scientific Advisory Committee, Food Safety Standard Authority of India was the Chief Guest of the valedictory function. He informed the audience that the expertise of ICAR-CIFT was sought to formulate and implement hygiene and quality parameters across the fish value chain. The European Union had imposed a ban on seafood products from India due to nonconformity to EU directives on quality standards and monitoring.The consistent effort played by CIFT along with other agencies like Export Inspection Council and Marine Product Export Development Agency has helped to lift the ban on December 23, 1997. Any effort to promote seafood business will be futile unless hygiene and food safety aspects are properly considered, he added.

	
Valedictory address by Chief Guest	Felicitation of Chief Guest

The participants appreciated that they could get exposed to innovations in various areas like harvesting technologies, value addition, quality assurance, drying equipment's apart from nutritional aspects and microbial issues related to fish consumption. Also, the participants informed about the training received on institutional and social aspects of India fisheries sector. Unlike the routine training programmes, the implementation of the new learnings in action will be monitored by CIFT through a back at work plan programme.

Participants from various countries expressed keen interest to take technologies developed by CIFT like de-scaling machine, chilled preservation, silage making, solar drying etc. to their countries. They have also shown interest in replicating the extension approaches for dissemination of technologies among fisher folks in their respective countries.


Distribution of certificates

Dr. C.N. Ravishankar, Director, ICAR-CIFT presided over the function. Dr. Chandrasekhara, Director, MANAGE, Hyderabad briefed about the 'Feed the Future' Programme. Dr. A.K. Mohanty, Head EIS Division presented the report of the training programme. Dr. Susheela Mathew, Head, Biochemistry and Nutrition Division welcomed the audience and Dr. Leela Edwin , Head Fishing Technology Division offered vote of thanks.

9. The way forward

The FTF ITT is one of the first programmes in the country to initiate functional linkages with African countries through capacity development. Though the executives learned a great deal of improved fisheries technologies, there is an essential need to mentor them for multiplying the positive effects of new learning. Though the Back At Work plans provide a channel to mentor the executives, there is an essential need to create a new platform for technology transfer and exchange visits. Many executives have indicated this need. Considering the importance of fisheries in the food and nutritional security of African nations, there is a need to open up new avenues through FTF ITT.

10. Annexure-1

भाकृअनुप - केन्द्रीय मात्स्यिकी प्रौद्योगिकी संस्थान
ICAR - CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
सिफ्ट जंक्शन, विल्लिंडन आईलंड, मत्स्यपुरी पी.ओ., कोचिन, - 682 029, केरल, भारत।
CIFT Junction, Willingdon Island, Matsyapuri P.O., Cochin, - 682 029, Kerala, India.
(ISO/IEC 17025: 2005 Accredited & ISO 9001: 2008 Certified)

FEED THE FUTURE - INDIA TRIANGULAR TRAINING (FTF-ITT) PROGRAMME

on

RECENT TRENDS IN HARVEST AND POST-HARVEST TECHNOLOGIES IN FISHERIES

Duration : 12-26September, 2017 Venue : ICAR-CIFT, Cochin, Kerala

PROGRAMME SCHEDULE

Date (Day)	Time	Particulars
12.09. 2017 (Tuesday)	09.30-10.00 hr	Registration **------Ms. Rehna Raj, Dr. AniesraniDelfiya D.S. and Mrs. Sruthi P.**
	10.00-11.00 hr	Opening Session (Ice breaking, Climate setting, Course briefing, Housekeeping and Norms, Pre-evaluation,) **------Dr. A.K. Mohanty & Dr. M.V. Sajeev, EIS Divn., ICAR-CIFT**
	11.00-13.00 hr	Visit to NABL accredited Laboratories B&N Laboratory – 30 mins. FP Laboratory – 30 mins. QAM Laboratory- 30 mins. MFB Laboratory - 30 mins. **------Dr. M. Baiju, ACTO, EIS Divn., ICAR-CIFT**
	13.00-14.00 hr	**Lunch Break**
	14.00-16.30 hr	Visit toNet Mending Workshop, ATIC, Fish Processing Pilot Plant, Engg. Workshop&ABI Unit FT Museum &Net Mending Workshop - 45 mins. Fish Processing Pilot Plant - 45 mins. Engg. Museum and Workshop - 30 mins. ATIC &ABI Unit - 30 mins. **------ Dr. M. Baiju, ACTO, EIS Divn., ICAR-CIFT**
13.09. 2017 (Wednesday)	10.00-11.30 hr	**INAUGURATION**
	11.30-12.00 hr	**Hi-Tea& Group Photograph**
	12.00-13.00 hr	Indian fisheries: Harvest and Post-Harvest Scenario

Date (Day)	Time	Particulars
		------Dr. Ravishankar C. N., Director, ICAR-CIFT
	13.00-14.00 hr	**Lunch Break**
	14.00-15.00 hr	Importance of responsible fishing and its strategic implementation for sustainable fisheries **------Dr. Leela Edwin, Head, FT Division, ICAR-CIFT**
	15.00-15.30 hr	**Tea Break**
	15.30-16.30 hr	Recenttrends in fishing gear materials **-----Dr. Saly. N. Thomas, Pr. Scientist& Smt. Manju Lekshmi N., Scientist,FT Division, ICAR-CIFT**
14.09.2017 (Thursday)	09.30-10.00 hr	*Course review by the participants*
	10.00-10.45 hr	Design and operation of trawls **------Dr. M.P. Ramesan, Pr. Scientist& Mr. Renjith R.K., Scientist, FT Division, ICAR-CIFT**
	10.45-11.00 hr	**Tea Break**
	11.00-11.45 hr	By-catch reduction devices in trawling **------Dr. Madhu V.R., Sr. Scientist& Mr. Paras Nath Jha, Scientist, FT Division, ICAR-CIFT**
	11.45-12.30 hr	Nano application in material protection **------Dr. Muhamed Ashraf P., Pr. Scientist & Mr. Chinnadurai S, Scientist, FT Division, ICAR-CIFT**
	12.30-13.15 hr	Energy saving in fishing vessels **------Dr. M.V. Baiju, Sr. Scientist, FT Division, ICAR-CIFT**
	13.15-14.00 hr	**Lunch Break**
	14.00-16.30hr	Craft and gear material testing - **Lab Session**
15.09. 2017 (Friday)	09.30-10.00 hr	*Course review by the participants*
	10.00-10.45 hr	Handling and chilled storage of fish **------Mrs. Mandakini Devi H. and Ms. Rehna Raj, Scientists, FP Division, ICAR-CIFT**
	10.45-11.00 hr	**Tea Break**
	11.00-11.45 hr	Low temperature preservation of fish products **------Dr. George Ninan, Pr. Scientist and Mr. Joshy C.G., Scientist, FP Division, ICAR-CIFT**
	11.45-12.30 hr	Thermal processing of Fish **-------Dr. Anuj Kumar, Scientist, FP Division, ICAR-CIFT**
	12.30-13.15 hr	Smoking of Fishes **------Mr. K. Sathish Kumar, Scientist, FP Division & Mrs. Priya E.R., Scientist,QAM Division, ICAR-CIFT**

Date (Day)	Time	Particulars
	13.15-14.00 hr	**Lunch Break**
	14.00-16.30 hr	Value added fish products **------ Dr. Binsi P.K.& Mrs. Sreelakshmy, Scientists, FP Divn., ICAR-CIFT**
16.09. 2017 (Saturday)	09.30-10.00 hr	*Course review by the participants*
	10.00-10.45 hr	Extruded fish products **------ Mrs. Sarika, Scientist, FP Division &Mr. DevanandaUchoi, Scientist, QAM Division, ICAR-CIFT**
	10.45-11.00 hr	**Tea Break**
	11.00-11.45 hr	Non-thermal processing of fishes **------Dr. J. Bindu, Pr. Scientist, FP Division, ICAR-CIFT**
	11.45-12.30 hr	Vacuum packaging & MAP **------Dr. C.O. Mohan, Sr. Scientist, FP Division, ICAR-CIFT**
	12.30-13.15 hr	Seafood packaging **------Mr. Sreejith S., Scientist, FP Division, ICAR-CIFT**
	13.15-14.00 hr	**Lunch Break**
	14.00-14.45 hr	Utilization of shellfish processing discards **------Dr. Zynudheen A.A., Pr. Scientist, FP Division, ICAR-CIFT**
	14.45-16.30 hr	Utilization of secondary raw material from fish **------Dr. K. Elavarasan, Scientist, FP Division, ICAR-CIFT**
17.09. 2017 (Sunday)	Full day	Field visit **-----Dr. Sajesh V.K., Scientist &Mr. Rakesh M. Raghavan, EIS Division, ICAR-CIFT**
18.09. 2017 (Monday)	09.30-10.00 hr	*Course review by the participants*
	10.00-10.45 hr	Nuetraceuticals from Fish and Fish Wastes: Scopes and Innovations **------Dr. Suseela Mathew, Head & Mr. Tejpal C.S., Scientist, B&N Division, ICAR-CIFT**
	10.45-11.00 hr	**Tea Break**
	11.00-11.45 hr	Profiling of macro and micronutrients in sea food **------Dr. R. Anandan, Pr. Scientist& Mrs. Minimol V.A., Scientist, B&N Division, ICAR-CIFT**
	11.45-12.30 hr	Microencapsulation for food fortification **------Dr. Asha K.K., Sr. Scientist, Mr. Anas K.K., Mrs. Minimol V.A & Mrs. Lekshmi G. Kumar, Scientists, B&N Division, ICAR-CIFT**
	12.30-13.15 hr	Biochemical analysis of seafood- Lab Session **-------Mr. Tejpal C.S., Mrs. Lekshmi G. Kumar, Mr. Anas K.K., Scientists,B&N Division, ICAR-CIFT**

Date (Day)	Time	Particulars
	13.15-14.00 hr	**Lunch Break**
	14.00-14.45 hr	Technological innovations in fishery engineering **Dr. Manoj P. Samuel, Head, Engg. Division, ICAR-CIFT**
	14.45-15.30 hr	Novel drying techniques in fish processing and preservation **------Dr. S. Murali, Scientist, Engg. Division, ICAR-CIFT**
	15.30-15.45 hr	**Tea Break**
	15.45-16.30 hr	Pre-processing of fish and solar fish drying **------Dr. AniesraniDelfiya D.S., Scientist, Engg. Division, ICAR-CIFT**
19.09. 2017 (Tuesday)	09.30-10.00 hr	*Course review by the participants*
	10.00-10.45hr	Microbiological aspects of fish and fishery products **------Dr. M.M. Prasad, Head; Mr. N. Ranjit Kumar &Mrs. Greeshma S.S., Scientists, MFB Division, ICAR-CIFT**
	10.45-11.00 hr	**Tea Break**
	11.00-11.45 hr	Prophylactic Health Products in aquaculture **------Dr. Toms C. Joseph, Pr. Scientist; Mr. K. Ahmed Basha & Mr. Abhay Kumar, Scientists, MFB Division, ICAR-CIFT**
	11.45-12.30 hr	Hygiene Indicator bacteria in sea-foods and aquaculture **------Dr. G.K. Sivaraman, Pr. Scientist& Mr. V. Radhakrishnan Nair & Mrs. Muthulakshmy V, Scientists, MFB Division, ICAR-CIFT**
	12.30-13.15 hr	Antimicrobial resistance (AMR) in aquatic products **------Dr. Murugadas V.& Mr. Ezhil Nilavan S., Scientists, MFB Division, ICAR-CIFT**
	13.15-14.00 hr	**Lunch Break**
	14.00-14.45hr	Designing Food Safety Management System **------Dr. T.V. Sankar, Director of Research, KUFOS, Cochin**
	14.45-15.30 hr	Seafood quality assurance and safety regulations **------Dr. S.K. Panda, Sr. Scientist, QAM Division, ICAR-CIFT**
	15.30-15.45 hr	**Tea Break**
	15.45-16.30 hr	Determination of chemical and biological contaminants in seafood **----Dr. Pankaj Kishore & Mrs. Laly S.J., Scientists, QAM Divn., ICAR-CIFT**
20.09. 2017 (Wednesday)	09.30-10.00 hr	*Course review by the participants*
	10.00-10.45hr	HACCP Concepts **----Dr. K. Ashok Kumar, Head, FP Division, ICAR-CIFT**
	10.45-11.00 hr	**Tea Break**
	11.00-11.45 hr	Ornamental fisheries **------Dr. Anna Mercy, Retd. Professor (Marine Biology), KUFOS, Cochin**
	11.45-12.30 hr	Innovative extension methods for technology dissemination in fisheries

Date (Day)	Time	Particulars
		-------Dr. A.K. Mohanty, Head, EIS Division, ICAR-CIFT
	12.30-13.15 hr	Fish stock assessment and management for sustainable fisheries **------Dr. Geethalekshmi V., Pr. Scientist, EIS Division, ICAR-CIFT**
	13.15-14.00 hr	**Lunch Break**
	14.00-14.45hr	Prospects of micro-financing in fisheries sector **-------Dr. Ashaletha S., Pr. Scientist & Dr. Sajesh V.K., Scientist, EIS Division, ICAR-CIFT**
	14.45-15.30 hr	Gender impact on community based Fishery Development **-------Dr. Nikita Gopal, Pr. Scientist, EIS Division, ICAR-CIFT**
	15.30-15.45 hr	**Tea Break**
	15.45-16.30 hr	Technology Application, Refinement and Transfer through KVKs **------Dr. Sajeev, MV., Sr. Scientist& Dr. Rejula K., Scientist, EIS Division, ICAR-CIFT**
21.09. 2017 (Thursday)	09.30-13.00 hr	Visit to different institutes ICAR-CMFRI, NIPHAET &Processing Industries **------Dr. Chandrasekhar V., Scientist and Mrs. Sruthi P. EIS Division, ICAR-CIFT**
	13.00-14.00 hr	**Lunch Break**
	14.00-14.45 hr	Advanced aquaculture techniques (at CMFRI) **------Dr. Imelda Joseph, Head, ICAR-CMFRI**
	14.45-15.30 hr	Inland fisheries (at CMFRI) **-------Dr. Rani Palaniswamy, Pr. Scientist & SIC, CIFRI RC, Cochin**
	15.30-15.45 hr	**Tea Break**
	15.45-16.30 hr	Fish genetic resources (at CMFRI) **------ Dr. V.S. Basheer, Pr. Scientist & SIC, NBFGR RC, Cochin**
22.09. 2017 (Friday)	09.00-13.00 hr	Developing suitable EDP module for fish-preneurship **------Dr. Mathew C.D., Assoc. Faculty & Mr. Shibin Mohamed T. K., Entrepreneurship Development Institute of India, GOI, Angamaly, Cochin**
	13.15-14.00 hr	**Lunch Break**
	14.00-16.30 hr	Field Visit
23.09. 2017 (Saturday) & 24.09. 2017 (Sunday)	Two Full days	Field Visit **------Dr. M.V. Sajeev, Sr. Scientist &Mr. Rakesh Raghavan, TA, EIS Divn., ICAR-CIFT**
25.09. 2017 (Monday)	09.30-10.00 hr	*Course review by the participants*
	10.00-10.45 hr	Value chain management in fisheries **------Dr. Jeyanthi P.& Mr. V. Chandrasekhar, Scientists,**

Date (Day)	Time	Particulars
		EIS Division, ICAR-CIFT
	10.45-11.00 hr	**Tea Break**
	11.45-13.15 hr	Back to Work Project Presentation by the country participants
	13.15-14.00 hr	**Lunch Break**
	14.00-15.30 hr	Back to Work Project Presentation by the country participants…..contd.
	15.30-15.45 hr	**Tea Break**
	15.45-16.30 hr	Back to Work Project Presentationby the country participants--- contd.
26.09. 2017 (Tuesday)	09.30-13.00 hr	Back to Work Project Presentation by the country participants(contd.) followed by **Panel Discussion**
	13.00-14.00 hr	**Lunch Break**
	14.00-14.30 hr	Post Evaluation ---- All the Course Coordinators
	14.30hrs onwards……	**VALEDICTION**