Entrepreneurship avenues in fisheries post-harvest sector

The following article is a part of FIFP webinars conducted on 6th March, 2021 on the topic "Entrepreneurship in fisheries".

Note from the Chief Editor:

The main theme of FIFP webinar conducted on 6th March, 2021was Entrepreneurship in fisheries. Three presentations were made that covered Entrepreneurship in seafood industry; Entrepreneurship avenues in fisheries post-harvest sector; and Entrepreneurial opportunities in aqua-farm tourism. Dr George Ninan brought out the importance of developing entrepreneurship in fisheries particularly in the post-harvest sector. In this context, he discussed several options for commercialization of post-harvest technologies in fisheries. He described production processes and benefits of value-added products and products prepared from fish waste. Waste management of bulk waste generated in domestic fish markets and fish processing facilities and full utilization of available fish waste through value addition was stressed. He highlighted the contribution of ICAR-CIFT, Kochi in entrepreneurship development in fisheries sector through agribusiness incubation (ABI). The ABI is an initiative of ICAR for creating business enterprises by technology transfer, promoting innovation and ideas among entrepreneurs through establishment of Zonal Technology Management Centres- Agri Business Incubation Centres (ZTM-ABI). The list of entrepreneur-ready technologies developed by ICAR-CIFT in the field of Harvest, value addition, waste utilization, engineering and health care and quality assurance was provided. He presented an analysis of the key constraints and challenges faced by ZTM-ABI clients along with the systems and protocols developed to address them.

Introduction

Fish and fisheries contribute substantially to local food consumption, livelihood, and export earnings of countries. The quantity of fish produced from different sectors has been increasing over the years and the growth is much higher for the developing countries. There was an increase of over 42 percent in the global fish production from both capture and aquaculture sectors over the last two decades reaching total of 179 million tonnes in 2018. Aquaculture contributed 95 percent to this increase.

The per capita availability of fish as food has increased from 9.0 kg (live weight equivalent) in 1961 to over 20.0 kg in 2018, at an average growth rate of 1.5 percent per year (FAO, 2020). The rise in the total fish production, is due to a combination of different factors, in the value chain in terms of policy interventions, infrastructure development, reduction in losses, and due to the increasing purchase power. It is estimated that globally in 2017, fish accounted for 17 percent of the total animal protein and, 7 percent of all proteins. This contribution of fish to the total animal protein is about 50 % in countries that lack other source of proteins and small Island developing States.

It is estimated that globally about 35% of the fish from capture and aquaculture is either lost or wasted every year and this is a serious issue, which has garnered much interest in research, policy, and implementation. Fish losses is mostly due to the inefficiency in the value chain and key issues being the lack of infrastructure, services, and access to suitable markets. Most of the studies related to losses in fisheries, addressed the physical losses while those related to the loss in quality of fish due to inefficiencies in the value chain are limited (Kruijssen *et al.*, 2020). Globally, the total waste in terms of discards, between 2010 and 2014, in marine fisheries has been estimated as 9.1 million tonnes, with values ranging from 6.7 to 16.1 million tonnes, depending on the fisheries (Roda *et al.*, 2019).

The total number of fishing vessels in 2018 was estimated at 4.56 million, which showed a decline of 2.8 percent compared to 2016. Asia with a total number of 3.1 million vessels, contributes about 68% of the total and 75% of these vessels are motorized (FAO, 2020).

Due to the prevalence of tropical shrimp trawling that contributes significantly to the discards, countries in South Asia have significant quantities of discards. India, which has one of the largest number of trawlers (35,228) operating in the region has adopted many technical measures such as seasonal closures and gear-based restrictions to improve the deteriorating state of marine fisheries (CMFRI,2012).

The countries in South Asia contribute about 10% of the global production and about 3.7% of the total trade in fish and fishery products. The countries in the region also show wide variation in the per capita availability of fish, with average protein from fish availability at 41.4 g/capita/day for Maldives, which is one of the highest and 0.065 g/capita/day for Afghanistan, which is one of the lowest, when compared to the global average of 5.6 g/capita/day (FAO, 2020).

Role of fish in Nutrition

Fish, including crustaceans and molluscs play a major role in human nutrition by providing at least 20% of protein intake for a third of the world's population. The importance of fish in the human diet and its beneficial effects has been proven in terms of food security as well as in combating under nourishment and micronutrient deficiencies in developing countries (Kawarazuka & Béné, 2011). World trade of fish for human consumption is projected to total 45.8 Mt live weight by 2028, up 11% on the 2016-18 base period. Exports of fish for human consumption are expected to concentrate in fewer exporting countries. Live, fresh or chilled is often the most preferred and highly priced form of fish and represents the largest share of fish for direct human consumption (45 %) followed by frozen (31 %), prepared and preserved (12 %) and cured (dried, salted, in brine, fermented smoked) (12 %). Freezing represents the main method of processing fish for human consumption; it accounted for 56 % of total processed fish for human consumption and 27 % of total fish production (FAO, 2018). Throughout the world, post-harvest fish losses are a major concern and occur in most fish distribution chains; an estimated 27 % of landed fish is lost or wasted between landing and consumption. When discards prior to landing are included, 35 % of global catches are lost or wasted and therefore not utilized (Gustavsson *et al.*, 2011). Climate change,

weather variability and changes in the frequency and extent of extreme weather events are anticipated to have a major impact on the availability and trade of fish and fish products mainly through habitat destruction, changes in fish migration patterns and natural productivity of fish stocks.

Fish contains macro and micro elements, which are very vital for human health. Calcium in fish contributes to vital roles in human body viz maintaining required calcium level in blood, bone and cells and also for the proper secretion of hormones like insulin. Children, pregnant and lactating women require large amount of calcium and phosphorous, which can be met from sufficient consumption of fish. The role of phosphorous at cellular level is immense as in the production of energy through ATP or in activation of enzymes and cell signaling molecules by phosphorylation. Apart from calcium and phosphorus, fish is rich in Sulphur, potassium and magnesium. Fish contain significant amount of phosphorus which is essential for the above-mentioned vital body functions. Sulphur is a component of amino acids, cystine, methionine and B vitamins thiamine and biotin. Potassium plays a key role in electrolyte balance, maintains membrane potential. Magnesium is an element which is part of more than 300 metabolic reactions in the body. Iron deficiency can alter metabolic processes adversely leading to anaemia especially in children, lactating and pregnant women. Many varieties of fish are good source of iron and copper. For iron absorption in the body, copper plays a significant role, it is also necessary for hematologic and neural functions. Zinc is another micronutrient essential for the body functions, nearly 100 enzymes depend on zinc for their reactions. Its role varies from cell replication, protein synthesis to wound healing. Fish is considered as a delivery source for Zn and Mn. Cobalt, chromium, selenium and nickel are other micronutrients in fish, whose beneficial roles in human body have been well established. Identified protein rich, oil rich and micronutrient dense fish species could be utilized in community nutrition programs like 'mid-day meal' program in operation in schools in countries like India. Such species include *Anabas testudineus, Amblypharyngodon mola, Puntius sophore, Tenualosa ilisha* which could provide wholesome nutrition to consumers (Mohanty *et. al,* 2019).

Marine fish contain significant quantity of Omega-3(n-3) fatty acids such as DHA and EPA. These contribute significantly in the functioning of vital organs viz., heart, brain, immune and reproductive systems. (Connor,2000). Their role in ameliorating many diseases, has been reported extensively viz., cardiovascular disease (Nordoy,2001), depression, lupus (Duffy *et. al,*2004), rheumatoid arthritis (Cleland et.al 2003) psoriasis, crohn's disease (Tsujikawa *et. al,*2000), ulcerative colitis (Alex and Triadafilopoulos,1992) asthma (Nagakura *et.al,*2000), kidney disorders, diabetes and cancers (Larsson *et. al,*2004).

The development of a more diversified fish processing sector with raw and processed fishery products could be witnessed over the years. There are many references for the development of by-products from fish and their use in feed, fish silage, fertilizer, biofuels, food packaging, human food or nutraceuticals or pharmaceuticals (Arvanitoyannis & Kassaveti, 2008; Govindharaj, Roopavath, &

Rath, 2019; Herpandi, Rosma, & Wan Nadiah, 2011; Kim & Mendis, 2006; Yuvaraj *et. al,* 2016). However, its use in food and nutraceutical fields is still challenging because of safety, stability and bioavailability issues and lack of good market potential.

Post -harvest technologies in fisheries: options for commercialization

Coated fish products

The most prominent among the group of value-added fishery products is the battered and breaded products. Fish is processed to mince and further used for the production of fish mince-based coated products. Fish mince can be used for processing a variety of value-added products. Depending on the type of product, a frozen storage life up to 6 months without any appreciable quality deterioration can be expected for these categories of products.

A coated product is one which is coated with another food stuff. Coating provides a crispy texture and appealing color /flavor; enhances the nutritional quality; the coatings can be fortified with necessary nutrients; acts as a moisture barrier minimizing moisture losses during frozen storage/microwave reheating and acts as food sealant by preventing natural juices from flowing out. Preparation of battered and breaded products consists of various steps such as portioning /forming, pre-dusting, application of batter, breading, flash frying, freezing, packing and storage. An array of coated products such as patties, balls, burgers, fish fingers, dehydrated fish mince, cutlets etc. can be prepared from fish mince.

Benefits of coated products

- Value-added seafood-based products in ready-to-cook or ready to serve convenient form
- Effective utilization of by-catch fishes
- Enhances the nutritional quality; the coating can be fortified with necessary nutrients.
- Value addition increases the bulk of the substrate thus reducing the cost element of the finished product.
- The product is protein enriched snack food

The business margin of value-added product processing can reach two to three-fold from the main input value. The value added and the business margin of fisheries product processing is very big irrespective of the scale of their operation.

The production and marketing of coated fish products provides opportunities for new businesses, with associated economic and employment benefits. Main raw material as well as rest raw material such as processing frame meat can be processed into a wide range of these products to increase their economic value. In addition, exported value-added products may generate substantial foreign exchange earnings and further employment benefits.

Fish Sausage

The demand for fish products is increasing both at domestic and export fronts due to its proven health benefits. Among the variety of value-added products, sausages have special place in the market. Sausages prepared from fish has the advantage of health aspects apart from its unique taste. Although fish sausage is highly relished, the availability of sausage on the shelf is limited to chicken, pork or other meat varieties. However, there is a good market for fish sausage if promoted suitably.

For fish sausage, a wide variety of fishes can be used ranging from lean to fatty variety. Sausages are usually prepared from minced meat mixed with ingredients like fat, binders, fillers, spices, salt etc. according to the consumer's preference. The advantage of sausage preparation is its adaptability to variety of ingredients resulting in distinctly different taste which increases the variety of sausage products. Fish mince is mixed with additives (starch, sugar, salt, spices, fat) and stuffed into cylindrical casings, either natural or synthetic casings of desired size and marketed either as fresh, cooked, smoked or dried.

Benefits of sausages

- Sausages are ready-to-cook or ready to serve convenient products
- Suitable for wide variety of fishes which increases the variety of products
- Product can be modified using different ingredients depending on the consumers choice
- Provides good quantity of nutrients with calorie value of 250 – 300 kcal 100 g^{-1}

The business profit of sausage processing can be double or higher in comparison to the initial raw material. Utilization of under-utilized species as well as fish processing frame meat can be an added advantage, thus enhancing the business profitability.

Production process for sausage is very well established and can be easily adopted for automation. Sausages can be prepared from wide variety of fishes with varying amount of fat including combination sausages from different fishes. Market for fish sausage is very bright on account of its delicacy, nutritional health benefits as well as convenience.

Fish/Prawn Pickle

Fish pickle is one of the most prominent and age-old delicacy relished by many communities across the world. Fish/prawn pickle, if made properly under hygienic conditions adding requisite quantity of salt, spices and preservatives, would have a high shelf life. Most of the seafoods like prawn, tuna, seer fish etc. are ideally suitable for making fish pickles.

Apart from staple foods, people like spicy adjuncts to make the food palatable and relishing. Pickles are good appetizers and digestive agents. There are several varieties of pickles which are consumed throughout the year. In this context, pickle, a spicy preparation, has gained importance in Indian menu. Preparation of pickles is an old art and a variety of these products are made in Indian homes. The basic principle of pickling is curing of fish by salting, acidifying by addition of vinegar

and/or oil and spices. In general, pickling enhances the product shelf life to six months and more.

Benefits of fish/prawn pickles

- These are ready-to-serve convenient form of products used as side dishes in Indian menu
- Effective utilization of by-catch fishes
- A means of value addition- reducing the cost element of the finished product.
- Shelf-stable nutritious commodity

There is a huge scope of upscaling this technology by means of utilizing the less-utilized raw material to high delicacy cured products with the addition of other ingredients. Based on the scale of operation, the level of profit margin can be improved several folds.

Like vegetable pickles, fish pickle has also gained popularity in the recent past. The demand for these types of ready-to-serve fishery products is increasing day by day among the non-vegetarian population. There are very few national brands and the bulk of the market is controlled by the local manufacturers. Demand for ready-to-serve fish products is increasing in the domestic sector as well as having a potential export market. Apart from that, individual households, hostels, restaurants, roadside eateries, canteens etc. are bulk consumers. Potential investment in this field by considering the aspects like proper product marketing, attractive point of sale, publicity and handsome commission to retailers can have a wide impact for this technical innovation.

Fish Wafers / Crackers

Seafoods play a major role in satisfying the demands of the diverse global customers on account of its availability, accessibility, nutritional as well as quality and safety aspects. These valuable commodities are simultaneously convenient due to its potentiality for high product diversification. Being one of the fastest growing economies and the second largest consumer market in the world, India offers a strong platform for the processed seafood industry. Dried, ready-to-fry-and-serve wafers/crackers, employing carbohydrate as the main base and incorporating salt and several other ingredients with or without spices are very popular.

Preparation of starch based dried products is an age-old practice in the Indian households and has wide popularity in the domestic market. Incorporation of protein rich ingredients into these products can upgrade their nutritive value as well as enhance the taste. The basic principle involves the addition of starch into the fish mince together with spices and other ingredients which is blended, cooked for gelatinization and further cut and dried to a moisture content less than 10%. Being dried products, fish wafers have a shelf life of one to two years. By-catches as well as processing frame meat can be very well employed as raw material for the preparation of these dehydrated commodities.

Benefits of fish wafers/crackers

- Ready-to-fry or ready-to-serve convenient form
- Effective utilization of by-catch fishes as well as processing discards like frame meat.
- Fortification of carbohydrate-based commodities.
- Product diversification based on customized demand

Possibilities of upscaling the production of value-added products like seafood-based wafers/crackers are enormous as there is a rising demand for such products in the domestic as well as external market. The profitability of this technology can be extended based on the scale of operation and is projected to be high so as to obtain the returns on investment within a short period of time.

This technology can be adopted by small-scale entrepreneurs targeting the local market as well as commercial dealers oriented for domestic as well as export market. The investment involved for this technological innovation can be customized based on the targeted production attracting small-scale to large-scale business ventures.

Fish Paste

Fish paste is a value-added product prepared from deboned fish by mixing with condiments, salt and oil. In some cases, starch, sugar and skim milk powder is also added and chopped in a meat bowl chopper to get fine consistency and taste. Inclusion of ingredients could be customized based on the consumer needs. Fatty and non-fatty fishes of marine origin and fresh water fishes can be used for fish paste preparation. A variety of fishes with low economic value can also be employed for this value addition. Marine fatty fishes could serve as a rich source of omega-3 fatty acids and impart characteristic taste of fatty fishes. Incorporation of ingredients help in concealing the identity of the original raw material and improving the consumer acceptability. Fish paste in Ready-to-eat (RTE) form can be stored at ambient temperature with a shelf life of minimum 1 year.

Benefits of fish paste

- Very rich in highly digestible protein with well-balanced essential amino acids
- Can be customized to variety of taste
- It finds application in processing several 'convenience foods' like salad dressings, spread (bread spread / spread on roti / chapatti), condiments etc.
- Suitable for all age groups including infants, lactating women and aged community.

There is a huge commercial potential for the utilization of rest raw material as well as by-catch to commodities that require minimum investment. On account of the nutritional insecurity prevailing in the present scenario, a bright market is expected for products like fish paste in the country as well as overseas. These nutritious by-products simultaneously attract small-scale business ventures targeting the domestic market. It is a good option for large-scale production by

incorporating an array of species with diversified formulations for domestic as well as export market.

Fish Protein Powder

Fish powder is a product prepared from prime quality edible fish muscle. It is a protein-rich (75-85%) shelf-stable product intended for human consumption. The proteins present in fish powder are highly digestible (90-98%) and can supply all the dietary essential as well as non-essential amino acids. In addition, fish powder is also a good source of functional bio-minerals including selenium and zinc.

Fish powder consists of two variants viz., whole fish protein powder and hydrolysed fish protein powder including muscle protein hydrolysates and collagen peptide. The hydrolysed fish protein powder is more suitable for infants, aged population and for people having difficulties in protein digestion. The hydrolysed fish collagen powder is a high-value bioactive ingredient having applications in nutraceutical and functional food formulations and essentially recommended for arthritis patients as a supplement for bone regeneration. It can be packed in metalized polyester laminated with polyethylene and HDPE containers, glass bottles etc. for 6 to 9 months at ambient temperature.

Benefits of fish protein powder

- Source of nutrients like amino acids
- Possess various bioactive properties viz., antioxidant, anti-inflammatory, anti-hypertensive, antimicrobial, immune-modulator, appetite suppressor, cholesterol lowering agent, anti-obese, etc.
- Application as binder, dispersing agent, emulsifier, ingredient in restructured products (gelling agent), protein fortification, thickening agent etc.

On account of the rising demand for health promoting food commodities amongst the modern customers, a huge potential for products like protein powder is expected in the internal as well as export market. Small-scale business ventures focusing on the local market as well as established ventures targeting the domestic and export market can be potential investors to this technology for exploring its commercial possibilities.

Ready-to-Serve fish curry in retort pouches

The technology relates to a ready-to-serve fish curry in retort pouches. The technology provides a method for preparing the ready-to-serve fish curry in retort pouch with excellent storage stability and quality with a shelf life of more than one year at ambient temperature.

The preparation of the said ready-to-serve fish curry includes processing fresh fish, preparing a curry medium and finally mixing the processed fresh fish and curry medium in an appropriate ratio. The processing of fresh fish comprises of cutting fresh fish into streaks of 3-4 cm, washing in potable chilled water and cold blanching of the washed streaks. Curry preparation varies with region. Depending on the requirements, ingredients are processed and the curry media is prepared in

different styles like Mughlai, Punjabi, Kerala, Konkan, Oriya, Bengali, Manipuri etc. The processed fish curry medium is mixed in appropriate ratio to obtain the ready-to-serve fish curry and packed in the said retort pouch. The air inside the retort pouch is exhausted by steam injection. Subsequently the retort pouch is heat-sealed and subjected to retort sterilization at 121°C for a specified time.

Benefits of Ready-to-serve fish products

- The technology provides a method for preparing ready-to-serve fish curry in retort pouch with excellent storage stability and quality.
- The ready-to-serve fish curry is thermal processed and do not require any further processing before consumption.
- The thermal processing conditions have been standardized for this product in order to make it safe for consumers
- Fishermen will get better returns and consumers will get ready-to-serve safe products.

The production and marketing of ready-to-serve fish products provides opportunities for new businesses, with associated economic and employment benefits. There is a major scope for ready-to-serve fish products in the domestic as well as export market there by attracting business ventures on a small-scale as well as large-scale level.

Silage from fish processing discards

Fish silage can be defined as a product made from whole fish or parts of 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. Normally formic acid at the rate 3.5% of the weight of waste is added to the minced waste and stirred well intermittently.

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. After liquefaction, it is mixed with rice bran and dried. This is a base material in place of fish meal for making feed for various animals and fish. It is a simple process and it requires little capital equipment particularly if non-oily fish are used.

The minced fish is mixed with the acid and liquefaction takes place depending upon the temperature of the mixture, size of the offal, freshness etc. The warmer the fish and acid mixture, faster is the process. At 25^0C, the process needs 2 days for liquefaction, whereas at 15^0C, it needs 5 to 10 days and more at lower temperature. Temperature above 40^0C should be avoided as the enzymes may get deactivated. Periodic agitation will help liquefaction of the mixture. There are no problems in storage of fish silage if the correct acidity is maintained.

During storage, the protein becomes more soluble and there is an increase in free fatty acids if any fish oil is present. If silage is made from oily fish it is desirable to separate the oil after liquefaction. If the temperature of the silage is raised to 70-90^0C, the floating oil is separated by decantation or centrifugation.

Benefits of fish-based silage

- Total utilization of available fish waste
- Can eliminate the environmental hazard and valuable protein source can be protected.
- Generate employment opportunities for unemployed youth
- Scaled-up production for commercial application for poultry feed and other feeds

The production and marketing of fish silage and silage-derived feed provides opportunities for new businesses, with associated economic and employment benefits. Main raw material as well as rest raw material such as processing waste can be made into silage to increase their economic value. Since the product can be made at any location without much investment the product has high potential. Availability of alternative for fish meal as protein source will boost up the feed production and results in enhanced production of farm animal and fish.

Foliar spray from fish processing discards

The fish waste collected from fish processing industries and fish markets are homogenized. It is then cooked for half an hour with required quantity of fermentable carbohydrate. It is then cooled and added with starter culture of lactic acid bacteria. The product is then kept under covered condition for a period of 20-30 days and the supernatant is collected and packed in bottles as foliar spray. It is supplemented with potassium and magnesium at the required level.

Foliar feeding is an effective method for correcting soil deficiencies and overcoming the soils' inability to transfer nutrients to the plant. Tests have shown that foliar feeding can be 8 to 10 times more effective than soil feeding and up to 90 % 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 spraying is an effective method which gives predicted results 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.

Benefits of fish-based foliar spray

- The entre bulk waste generated in the domestic fish markets will be cleared within the market hours itself.
- Conversion of fish waste to high-value end products is a wiser option for the industry as they can potentially generate additional revenue as well as reduce the cost of disposal of these process discards.
- Better management practices for the waste generated in fish market is made available for the industry
- The high-end products such as foliar spray rich in nitrogen and minerals can be preferred inputs for the agricultural field and help in replenishing the soil health.

- The trend of terrace culture of vegetables and organic farming has picked up momentum among the city dwellers as it permits agriculture activities in limited space.

Fish waste-based foliar spray can be a preferred input for the agricultural field for high productivity. Development of high-end product such as foliar spray from fishery waste will provide better options for the utilization of processing discards from the primary fish processing sector.

Fish incorporated extruded snack products

Food extrusion is a size enlargement process where small granular or powdered particles are reinforced into larger sized particles with different shapes, texture, colour etc. It is used for the manufacture of food products such as ready-to-eat breakfast cereals, snack foods, soft moist pet foods and textured vegetable protein. Extruded snacks are gaining importance now-a-days due to their peculiar taste, texture and convenience. They are rich in calories and contain low levels of protein, which makes it necessary to fortify them with protein-rich diets. One of the possible ways for doing this is to utilize fish and fish proteins. Utilizing fish meat and fish portions and its derivatives like fish protein hydrolysate powder, dry fish powder etc. will add value to the low-cost and underutilized fish and shellfish, thus promoting their utilization.

In extrusion cooking, food material is heated either by an external heat source or through heat produced by friction and forced through dies to expand and extrude in desired shapes. Food extrusion using fish provides a great versatility for the development of low-cost, high-nutritive protein rich and convenient food products. The addition of flavouring is usually carried out on the dry extrudate by spraying or dusting, because of the changes caused by the losses of volatiles during extrusion. Metalized laminated pouches with nitrogen gas are used for the packaging of extruded products and can be stored at room temperature for 4 months.

Benefits of fish based extruded products

- Versatility - wide variety of products are possible by changing the ingredients, varying the operating conditions & and shape of the dies
- Low operational costs
- High production rate - operate continuously and have high throughputs
- Good quality products - involves high temperature applied for a short time and the limited heat treatment therefore retains many heat sensitive components
- No effluents - is a low-moisture process, eliminates water treatment costs and does not create problems of environmental pollution

The production and marketing of extruded snack products provides opportunities for new businesses, with associated economic and employment benefits. Fish meat as well as rest raw material such as processing frame meat can be processed into a variety of these products to increase their economic value. The combination of various ingredients makes the products in this product category tastier and crispier, and consequently the segment has been witnessing increasing demand from every

section of the society, especially from kids and younger generation. Utilizing fish meat and fish portions and its derivatives like fish protein hydrolysate powder, dry fish powder etc. will add value to the low-cost and underutilized fish and shellfish, thus promoting their utilization.

Livestock and aqua feed from fish processing discards

Wastes generated by fish processing industries are tremendous compared to other industries. Processing wastes from fishes vary with size and species accounting around 50-60% of total fish weight. In India the fish farming activity is expanding exponentially leading to high demand for quality feed. The waste generated from fish processing sector can be used for making good quality fish feeds. This in fact helps the processing industries to control pollution of the environment.

Bulk waste generated in domestic fish markets and fish processing facilities is collected in wet form. Further, the waste is crushed to fine paste and cooked along with other necessary ingredients to form a dough mass. The dough is further passed through a pelletizer and dried to a moisture content of less than 10%.

- The present technology introduces a process addressing a value-chain approach for the management of bulk-waste generated in the seafood sector, especially in domestic fish markets, by directly converting to a high-in-demand commodity such as aqua and livestock feed, which at present is at its infant stage.
- The entre bulk waste generated in the domestic fish markets will be cleared within the market hours itself.
- Conversion of fish waste to high-value end products is a wiser option for the industry as they can potentially generate additional revenue as well as reduce the cost of disposal of these process discards.

Most fish farms in Asia still rely on trash fish and fish meal to meet protein requirement. Hence the long-term sustainability of these farming activities is subjected to the technological inputs on alternative high protein source. As per current statistics, a minimum of 6 MT of fishery waste is being generated every year in the country. Fishery wastes contain a significant proportion of protein and other micronutrients, and hence can be considered as an ideal raw material for fish and livestock feeds. In recent years, due to intense farming activities worldwide, there is a major scope for livestock and aqua feeds in the domestic as well as export market there by attracting business ventures on a small as well as large-scale level.

Solar fish dryers

Fishermen catch fish as major aquatic products and are intended mainly for domestic consumption and sale in the local market. However, in case of excess catch, tremendous losses occur because the fishermen have neither access to markets in big cities nor to the international market due to poor product quality and absence of good marketing and distribution system. As an alternative, fisherman can convert the catch into value-added products viz., dried fishery products, smoked and salted fish etc. with enhanced shelf life and market value.

Solar drying is an alternative which offers numerous advantages over the traditional method, apart from being environmentally friendly and economically viable. In solar drying, a structure, often of very simple construction, is used to enhance the heating 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 hence lower moisture content of the final products. In order to overcome the heat energy supply during off sunshine hours, backup heating source is provided like LPG, Electrical and biomass.

ICAR-CIFT has developed various types of solar dryers with different backup systems suiting different product and client demands. ICAR-CIFT solar fish dryers are designed to supply maximum heat energy for drying from incident solar radiation.

Benefits of solar fish dryers

- Ideal for drying of fish, fruits, vegetables, spices and agro products
- Hygienically prepared premium quality uniformly dried product
- Economically viable and eco-friendly – maximum use of solar energy
- The drying time is reduced considerably with improved product quality.
- Lesser operating expenses
- Labour requirement is considerably reduced

The fish dryers are available from as small as 20 kg to 1ton capacity. The production size can increase if appropriate investment is made. The dried product business margin is very big irrespective of the scale of their operation. The benefit-cost ratio is always above 1.5.

Dried fishery products meet changing consumer life-style requirements. Offers better utilization of surplus catch that would otherwise go waste and conversion of low value fishes and by-catches into value-added dried product. Promotes employment, entrepreneur ventures and exports and also minimizes imports. Provides greater convenience to consumer through decreasing preparation time and minimizing preparation steps. In general, returns out of dried products are always greater than fresh fish/ shell fishes. The hygienic dry fish production technology has already been commercialized and lot of budding entrepreneurs have successfully taken up the technology.

Entrepreneurship development in fisheries sector through agribusiness incubation(ABI)

The Indian Council of Agricultural Research (ICAR) is the Apex Public Research Organization in India which has been playing a key role in the innovation processes concerning agriculture in the National Agricultural Research & Education System. ICAR harnesses and synergizes the innovative research mechanism and business support ecosystem by utilizing the efficient scientific manpower and vast resources. This ensures efficient utilization of innovative technologies, processes and products, thus leading to significant enhancement of the agri-economic system as a whole. As part of this drive and to ensure dissemination/commercialization of its research

outcomes and knowledge base, ICAR created an institutional mechanism connecting its 101 Research & Development (R&D) institutes, serving diversified fields like fisheries, horticulture, crop science, animal science and natural resource management.

ICAR institutionalized the concept of techno entrepreneurship through National Agriculture Innovation Fund (NAIF) schemes and today novel agricultural ventures are created in large numbers and nurtured through appropriate interventions, incentives and investments. Through various programmes under the NAIF scheme, the institutional mechanism was reinforced to protect the innovations/IPRs generated and was able to transform Agri-business Incubation (ABI) centres as a hub for technology transfer and techno-entrepreneurship. The NAIF scheme contributed towards development of an IP environment in ICAR and all its institutes were empowered to handle technology management activities at the institute level itself and liaison with private clients for the commercial transfer of their technologies. The middle-tier of this mechanism consists of 10 subject-specific Zonal Technology Management Centres (ZTMC) for facilitating public-private partnerships. These zonal centres are entrusted with the promotion of technologies available at various institutes from their respective zones. The central IP and technology management mechanism is operational from the ICAR Headquarters, and it deals with the policy matters and techno-legal aspects that arise from various institutes (ICAR, 2018).

ICAR has set up a total of 50 Agri-Business Incubators (ABI) in its various institutions during the past 10 years. Apart from these, many Technology Business Incubators (TBI), sponsored by the Department of Science and Technology (DST) are established at different State Agricultural Universities. As an institutional mechanism, independent units like Institute Technology Management Unit (ITMU) were constituted at each Research Institute, for better management and speedy process of IP protection, technology transfer and commercialization. ICAR also formed Agrinnovate India Ltd. (AgIn) as a "for profit" Company owned by Department of Agricultural Research & Education (DARE), Ministry of Agriculture, Government of India, to act as an effective interface between ICAR, ZTMCs and ABI Centres on one side and the stakeholders of agricultural sector on the other side.

Fisheries sector with its important role in the socio-economic development of the country has become a powerful income and employment generator, and stimulates the growth of a number of small, medium and large-scale industries. Taking into consideration the vast potential of the fisheries sector and the needs to promote techno-entrepreneurship among fishermen community, ICAR started India’s first fisheries Business Incubation Centre, the ZTMC in Fisheries and ABI at the Central Institute of Fisheries Technology, Kochi, Kerala, for establishing sustainable businesses in fisheries and allied agricultural fields. Numerous technologies have been transferred by the Institute through this incubation mechanism which goes in tandem with the flagship programmes of the Government of India such as Atma Nirbhar Bharat, Swatch Bharath and National Mission for Green India. The technologies commercialized effectively contributes to improving the livelihood of fishers by assuring returns even during off-season. The green technologies like

solar dryers and energy efficient fishing crafts support the country's commitment in reducing carbon emission. This industry-specific incubator also allows new firms to tap into local knowledge and business networks that are already in place. ZTM-ABI Centre offers their services to industries not only in Kochi, but also in other parts of the country through virtual incubation. Beyond promoting business growth, the Centre is also trying to bring its benefits to all the fisheries communities in India. Currently more than 200 small and medium-sized technologies and technology-enabled enterprises has helped to create good number of jobs.

The ZTM-ABI Centre is a platform to create new technology-based industries particularly in the fisheries sector. This entrepreneurial support system caters to its clients through strong technical and advisory support, and assist them to orient their resources in most optimized manner thereby yielding high productivity and economic value. This Centre promotes technology adoption and enable the entrepreneur to explore new ways of doing business through wide spectrum of activities. Pro-active and value-added business services are provided to registered clients in the form of technology transfer, contract research, consultancy, contract service, office space, certified state-of-the-art pilot level production facility, on-site guidance and specialized trainings to establish technology-based business enterprises. ABI Centre is established at a location with high fish production and vital markets, which makes it easily accessible to clients. It operates an important networking mechanism between R&D institutes, private industry, government agencies, academia and funding agencies. The Incubator allows start-ups as well as established business enterprises access to new innovations, cutting edge technologies and scientific know-how. Through virtual incubation, this ABI Centre is able to provide services to clients across the nation. Business incubation is a selective, comprehensive service offering that aims to accelerate the growth of SMEs.

The ZTM-ABI has analysed the key constraints and challenges faced by its clients and accordingly developed systems and protocols to address them (Table.1)

Table 1. Constraint redressal mechanism of ZTM-ABI

KEY CHALLENGES FACED	HOW ZTM-ABI CENTRE HELPS	VALUE TO THE ENTREPRENEUR
Identification of suitable Technology	A set of management metrics named Technology Readiness Level (TRL) has been devised to help in the assessment of the maturity period of a particular technology within a specific system and operational environment. ZTM-ABI Centre helps the clients in decision making through a seven-point TRL scale, developed on the basis of various categories of technology development stages and is very useful to clearly understand the project viability, maturity cycle and resource	Cost-effective management of advanced technologies and research results, and has become an essential entity to ensure the success of new initiatives in a field.

	requirements.	
Preparation of Business plans/ Project reports	Helps in the preparation of technology specific business plans / project reports detailing all necessary aspects, including technical, financial, commercial and operational strategies for the implementation of the project.	Assessment of project feasibility, other requirements and also very important for securing assistance from financial institutions.
Mobilising Finance	Even though ZTM-ABI Centre does not have a provision for seed funding, it has tie-ups with organisations like District Industries Centre (DIC), Kerala State Industrial Development Corporation (KSIDC) through which the clients can apply for financial assistance.	Adequate financing assists in development and growth of a business enterprise.
Capacity Building	Clients and their team members are provided adequate training to obtain, improve, and retain the skills, knowledge, tools, equipment, and other resources needed to adopt a particular technology and do their jobs competently.	Strengthens the skills, and resources that are essential for the business entities to survive and adapt.
Setting up of adequate infrastructure facilities / machinery	Apart from providing well furnished, air-conditioned office spaces for the clients to set up their office, ICAR-CIFT also provides access to its semi commercial pilot plant facilities. Thus, clients can take up commercial production using the machineries and instruments set up in the Pilot plant, without setting up a facility of their own, until successful test marketing phase.	Decreases the cost of starting a new business.
Access to business services	The Centre provides assistance and guidance in obtaining statutory approvals, registration, licenses, certifications etc.	Accelerates business development activities, saves time and money.
Branding / IPR Protection	Assist in the development of a product brand and provides guidance regarding proper intellectual property safeguards. Various IP protections can include trademarks, copyrights and patents, and the Centre addresses the client's requirements through Patent Attorney.	Safeguards the product identity, develops brand value and gets market advantage.
Networking	Mentoring, coaching and interaction with business support entities, fellow entrepreneurs, skill development units, central and state government agencies etc.	Learning, exchange of ideas, partnerships, business relationships etc

Marketing	The Centre promotes the client's products through the Institute's social media, websites, publications and showcase them in national and state level exhibitions, industry meets etc.	Accelerates brand promotion and gets a platform to promote the products and build business network.

Stages of Business Incubation

The clientele of ZTM-ABI Centre includes young start-up firms who need basic level technology support and training, to high-end business firms in need of R&D back up for development of diversified products. The Centre possess multi-tenant infrastructure facilities suitable to start a corporate level office for direct clients, within the premises of the Institute. Direct incubation is intended to handhold clients during their infancy period. Business Meets and industry-interface programmes are regularly conducted for sensitizing entrepreneurs, and identified candidates with viable business ideas are selected for incubation. Registered clients are allowed to meet scientists and business associates whenever required to optimize product formulation and identify suitable business strategies. This simple networking helps in easy delivery of incubation services and guides the client on basic principles of incorporating a business entity, understand its legal aspects, product branding, measures to ensure intellectual property protection, finance management, market study etc. Normally the residency period for direct clients is for one year, which may be extended based on the nature of the business and progress of company development. Whenever the start-up firms mature enough to operate a profitable business, the services and concessions provided, shall be withdrawn. The clients, apart from the registration fee to the Incubator, makes monthly payments for office space and pilot plant operations at a subsidized rate than the rates prevailing in the market. After exiting from the incubator, mentoring is continued on need basis.

The centre provides an array of services from idea stage to the product launch. Clients are assisted in translating their idea to a technology and further to a market-ready product or service. They can also select among the showcased technologies developed in the internal research laboratories and enter into a licensing deal. The entrepreneur-ready technologies developed by ICAR-CIFT are given in Table 2.

Table 2: Entrepreneur-ready technologies developed by ICAR-CIFT for fisheries sector

Harvest	Value addition	Engineering	Waste utilization	Health care / quality assurance
Fuel efficient multipurpose vessel for	Microencapsulated sardine oil	Solar dryer with electrical / LPG back up	Fish ensilage	Squalene and squalene powder

deep-sea fishing				
CIFT Turtle Excluder Device (CIFT-TED)	Seaweed Nutri-drink	Solar cabinet dryer with electrical back up	Foliar spray	Oyster protein hydrolysate (CIFTOPEx)
Device for juvenile fish excluder cum shrimp sorting	Ready-to-serve food products	Fish descaling machine with variable drum speed	Collagen peptide	Fish protein isolate from Bombay Duck
Fish aggregating devices	Ready-to-serve smoked products in TFS Cans	Table-top fish descaling machine with fixed drum speed	Collagen chitosan membrane	Glucosamine hydrochloride
Foldable traps	Seaweed and fish enriched noodles	Hand operated fish descaling machine	Chitin & chitosan from crustacean shell	Natural hydroxyapatite
Square mesh codend	Seaweed enriched cookies	Energy efficient effluent treatment plant	Carboxymethyl chitosan	Protein hydrolysate from tuna red meat
CIFT- Multi seam trawl	Fish kure - extruded product	Modern and hygienic mobile fish vending kiosk	Fish feed from processing discards	Deodorant for seafood processing units and fish markets
CIFT Semi-pelagic trawl system (CIFT-SPTS)	Fish sausage		Surgical sutures from fish gut collagen	Antiseptic ointment for prawn / fish handlers
Large mesh purse seine	Cured and dried fish products		Succinyl chitosan-based hydro-alcohol hand sanitizer	Fish calcium capsules
Short body shrimp trawl	Smoked masmin flakes			Test strips for sulfite residues
Cut-away top belly shrimp trawl	Fish wafers			Chlori test paper
Treated rubber wood canoe	Fish pickle			CIFT test kit for ammonia and formaldehyde adulteration in fish
FRP coated rubber wood canoe	Battered and breaded products			Design and development of modern hygienic

				fish markets
Treated coconut wood canoe	Laminated Bombay Duck			
CIFT Sun boat	Diversified products from black clam			

These technologies are further classified according to their Technology Readiness Level (TRL). Other services like patent portfolio management, fund mobilization, financial advisory, test marketing, prototype testing, feasibility analysis etc. also would be provided by the ZTM-ABI. Databases and software on IP search, market data analytics, funding sources etc. also are available in the Business incubation centre.

De-risking technologies for successful commercialization

Most of the times, the entrepreneurs find it difficult to up-scale the technologies which are successful at the lab level. This is mainly due to the constraints with respect to the economies of scale, precision in process/ protocols, management of big scale/ sophisticated machineries and instruments, HR management etc. Hence ICAR-CIFT has experimented a new mechanism called 'De-risking of technologies' using pilot scale facilities. Under this scheme, clients can take up commercial production using large-scale production facilities including machineries and instruments set up in the Pilot plant attached to the institute. This facility is limited to identified entrepreneurs for a limited period, essentially linked with test marketing and market behaviour analysis phase. They have to discontinue the use of pilot plant facilities once they are graduated with successful product in the market. The major facilities provided by the business incubator for de-risking are listed below:

1) Provides technology and know-how backed up with scientific results
2) Initial assessment of product and business
   - Assess the commercial viability of the business plan
   - Benchmark against best practices in the industry
   - Identify technology gaps and requirements
3) Regulatory, compliance and standards support
   - Training in quality regulations and related aspects
   - On-site inspections and formulate remedial measures
   - Provides assistance to secure regulatory and standards certifications
4) Infrastructure and production unit
   - State-of-the- art pilot level production facility
   - Well-furnished office space at prime business location
5) Training and skill development
6) Product development and testing
7) Formulation of company policies
8) Setting up of new facilities and up-scaling

Conclusion

Fisheries is a sunshine sector of food production providing nutritional security, livelihood support and gainful employment to millions of people in south Asian countries. Entrepreneurship is an important tool for promoting this sector and improving the economic development of a country. In this context the role of business incubators that supports the creation and growth of business through organizational and technical assistance, which at the same time contributes to the reduction of entrepreneurial failure, assumes great importance. The ZTM-ABI Centre model manages technologies / innovations, assists the entrepreneurs in seizing new business opportunities, and thus become key players in the growth of industries in fisheries and food processing sector.

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