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MODEL TRAINING COURSE

on

Pluralistic extension for upscaling secondary fisheries

(17 - 24 January, 2020)

Sponsored by

Directorate of Extension
Ministry of Agriculture & farmers' Welfare
Government of India

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FOREWORD

India ranks second in world fish production with estimated overall landings of 12.60 million metric tonnes (2017-18), a fourteen-fold leap over the production during 1951-52. Having achieved the considerable growth in fish production, it is high time to shift the focus to secondary fisheries for better value realization. Secondary fisheries comprise of wide range of products like value added foodstuffs from fish and fishery products, pharmaceutical and nutraceutical products from fish and other marine resources, proteins from fish waste, by products of industrial and culinary value etc. Apart from boosting the income and employment generation; secondary fisheries envision huge potential in augmenting economic utilisation of resources, market for innovative products developed from fish wastes and reduction in environmental pollution that add value and competitiveness to Indian fisheries sector. Technologies for developing products of nutritional, pharmaceutical and industrial application from fish and fishery waste have been developed and standardised by ICAR-CIFT/R&D institutes. Due to globalisation in trade and changing consumers' preferences, the R & D sector has been laying more emphasis on market driven technology development followed by its effective dissemination; the onus of which lies with fisheries extension by exploring the entrepreneurial opportunities in secondary fisheries and harnessing the synergy of various actors in Indian extension system to optimize their contribution towards the inclusive growth of the nation.

The model training course on '*Pluralistic extension for upscaling secondary fisheries'* sponsored by Directorate of Extension, Ministry of Agriculture & farmers' Welfare, Government of India, assumes a greater importance as the technical expertise developed over many decades by the institute could be shared with researchers and officials across India. During the training programme, twenty participants from different organizations were exposed to various technologies for the secondary fisheries and appropriate extension approaches for their wider dissemination. The topics for the programme were selected to give a comprehensive knowledge on technical and extension aspects related to secondary fisheries. This training manual consist of 21 chapters which cover different aspects of fish processing, waste utilization and value addition. It also includes topics on innovative extension approaches for technology dissemination in fisheries, scope and prospects for establishing fish based enterprises, value chain analysis and, stake holder analysis. I am sure that this training manual will be very useful for the officials, researchers and entrepreneurs. Customized extension approaches are imperative to augment the secondary fisheries sector.

Dr. Ravishankar, C. N.

Director

ICAR-Central Institute of Fisheries Technology

PREFACE

In fisheries sector, the extension system is pluralistic in nature with the proactive involvement of number of agencies like public, private and third sector actors catering to the information advisory and support service needs of fishers. The prevailing public extension service has been refurbished and reoriented with provision of technical backstopping, quality assurance, coordination of different actors and ensure synergy of various actors to optimize their contribution towards the welfare of farming community. Hence, any effort towards upscaling the secondary fisheries sector has to take into consideration of the multiple actors and stakeholders along the fishery value chain. Fisheries extension personnel will have a major role in fish-preneurial motivation, technology empowerment and skill upgradation of potential stakeholders and advocate proper sustenance mechanism at the gross root level to make this sector a sustainable one.

This book, through its various chapters, discusses the opportunities for developing high value products from fish and fish processing discards along with the extension approaches to augment the value chain for the innovative products. Also, it is an attempt to consolidate the research inputs in this field, particularly on the development of bioactive compounds, recovery of high value biomolecules; development of edible products; chitin, chitosan and its derivatives; etc. Further, strategies to develop entreprenurship and value chain for the commercial and societal application of R&D products are also discussed. We hope that this publication will serve as a guide for officials, researchers, extension professionals academicians, technologists and entrepreneurs engaged in the area of secondary fisheries.

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Innovative Extension Approaches for Sustainable Technology Dissemination in Fisheries

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Trends in aquaculture and fisheries

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

It is estimated that fish production generally contributes 0.5 – 2.5 % of GDP globally (Allison 2011). In spite of that globally an estimated population of more than 1.3 billion people are in extreme poverty (2016), 795 million people (2015-16) are estimated to be in chronic hunger and an estimated one third of children in the developing world under five years of age are stunted (Conway 2012). Fish is considered as the most affordable and frequently consumed animal-source food in low income food deficit countries in sub-Saharan Africa, Latin America and Asia

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(World Bank,2006).It is an important source of a wide range of intrinsic micronutrients, minerals and fatty acids. It accounts for about 17 % of most affordable, easily digestible, high-quality animal protein and 6.7 % of all protein, all essential amino acids, essential fats (e.g. omega-3 fatty acids), vitamins and mineralsthus contributing to a great extent to food and nutrition security in many Asian and African countries where large proportion of population are still in hunger and under nourished (Kent,1987). Besides small-sized fish species are excellent source of many essential minerals such as iodine, selenium, zinc, iron, calcium, phosphorus, potassium, and vitamins such as A, D and B. About 150 g of fish provides about 50–60 % of daily protein requirements for an adult. On an average, fish provides about 20–30 kilocalories per person per day. In addition, dietary diversity of the region is mainly influenced by different quantitative and qualitative attributes viz., income, price, preference, market, type and quality of products, cultural traditions, beliefs as well as various geographical, environmental, social and economic factors that influences the fish consumption pattern.

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

Major concerns in fisheries

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

considered as a promising food production sector for high quality protein food and providing livelihood to the rural populace, which needs to be more efficient and cost-effective. However, there is multitude of challenges associated with the growth of this industry.

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

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

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

Small-scale fisheries are normally characterized by low capital input activities, low capital investments, lack of equipment and labor-intensive operations followed by traditional fishers. They also usually operate as semi-subsistence, family-based enterprises, where a share of the production is kept for self-consumption (Garcia *et al*., 2008). Traditional fishers dominate the marine sector and they are socially deprived, educationally weak with very high occupational rigidity. There is inequity in the distribution of yield and effort in marine fishing in case of

traditional fishing communities. They are unorganized with least social security. The informal social security system in the form of sharing of earnings among the community prevailing in the traditional fishing is hardly seen in the mechanized fishing. There are also huge regional variations in productivity among them.

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

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

Extension systems for sustainable development

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

Hence, there is an urgent need to reform that agriculture allied sectors inholistic, scientific and systematic approach to meet the recent challenges due to climate change and global competitiveness so as to achieve sustainable production and growth under different agro-climatic conditions.

As per the report of world commission on Environment and Development (1987), sustainable development meets the needs of the present generation without compromising the ability of future generation to meet their requirements. The FAO committee on Fisheries (1991) defines sustainable development more elaborately as the management and conservation of national

resource baseand the orientation of technological and institutional intervention toensure the attainment of human needs for present and future generation including fulfilment of social and economicdemandsandconserving the natural resourcebase.In response to that FAO developed a code of conduct for Responsible Fisheries (FAO,1995) that provides principles and guidelines for ensuring sustainable exploitation of marine resources.Sustainable fisheries can be possible through responsible fishery, which envisages rational fishery management that address a range of issues dealing withresource status, environmental health, post-harvest technology, trade and export, socio-economic benefits, legal and administrative support.Sustainable agricultural systems must be resource-conserving, socially supportive, commercially competitive, and environmentally sound. Hence, the agriculture research system must place emphasis on generation of resource conservation technology (RCT) along with strong forward-backward linkage between research-extension system. It involves design and management procedures that work with natural processes to conserve all resources, promote ecosystem resilience and self-regulation, minimize waste and environmental damage, while maintaining or improving farm productivity and profitability (MacRae et al., 1990).

The role of extension in fisheries cannot be ignored. Strong extension system is the key to bring the desired changes to meet the presentdaychallenges related to sustainable fisheries. Basically, the end product of the fisheries extension system is to work with fisheries within an agro-climate and economic environment by providing suitable technologies to enrich knowledge and upgrade skills to improve better handling of natural fish resources and applying the cutting-edge technologies to achieve desired production level. Extension system plays a pivotal role in empowering fishers and other stakeholders to make fish farming more participatory, demand-driven, knowledge intensive and skill supportive for disseminating most appropriate technical, management and marketing skill to improve profitability in fisheries that can overcome the emerging challenges and concern, thus developing a synergistic pathway for enhancing productivity along with quality produce in order to sustain production base and ensure ecological and livelihood security. The extension system needs to disseminate a broad array of information starting from farm to fork in an integrated manner for safe delivery from field to the consumer considering all the aspects of conservation and production technologies, post-harvest management, processing and value addition. Such knowledge based decision should be incorporated in reshaping of extension approaches. In present scenario, the extension system envisages a transformation from technology driven to market driven extension, where fishers would give emphasis on commercialization of fish and fish based products, maintenance of quality, fulfilling consumers' demands, etc., in the program planning process for the effectiveness of any extension programme.

Further, with the advent of global competitiveness and market liberalization, our prevailing extension system has to be strengthened with innovative extension approaches to tacklethe recent challenges in fisheries *viz.*, climate change, weather aberrations, dwindling resources and quality

and safety of products; so that fishers can adjust their production portfolio keeping eye upon the emerging trends in food consumerism in domestic as well as global markets. Grooming fishers withproper information supportfor taking right decision related to fish productionessentially requires a strong network of extension systems, supported with government initiatives and strong linkage among extension scientists and functionaries working for fishery sector development. This would ensure the livelihood security of millions of fisher communities by improvingthe quality production and creating better job opportunities, which intends to bring out planned changes to meet the needs of the present generation without compromising the future generation's requirements.

Innovative extension approaches for technology dissemination in fisheries

Earlier in developing countries, the extension personnel were involved in diffusion of farm technologies generated by public research organizations, mostly disseminated through appropriate mechanism, viz., On Farm Trials (OFT), frontline demonstrations (FLD), field visits, fishers' meetings, media use, etc. This process had the conceptual backup from the 'diffusion of innovation' model. But in the last two decades, the paradigm shifts in development pivots to the enhanced concern for future generations to meet their basic needs, accordingly the nature, design and integration of fisheries technologiesare drawing attention of the extension professionals and practitioners across the globe. In India, different models for transfer of technology have been tested and some robust extension approaches have been validated. Furthermore, the frontline extension system of the country has been revisited and sharpened through fishersoriented approaches for technology adaptation and dissemination. The extension system in India has been designed to move beyond technology and beyond commodity through reciprocal fishers-research-extension linkages. Fish farmersstill suffer from lack of access to appropriate services like credit, inputs, market, extension, technologies etc. Keeping eye upon this, the World Development Report has focused on need to restructure and revamp agricultural extension system as a tool for realizing the growth potential of farm sector against the widening demand–supply pressures for ensuring sustainable fisheries, inclusive, pro-poor socio-economic development. Therefore,participatory technology development and participatory extension approaches emerged as a part of integration ofthe '*interdependence model*' and the '*innovation systems framework*' that offered more inclusive ways of involving the institution in technology generation, customization and diffusion. Extension approaches have to be redefined depending upon the components involved for sustainable growth and livelihood security of the farmers for which a conceptual framework has to be developed in response to recognizing and considering different livelihood assets viz., *human, social, physical, natural and financial resources*. Some of the following innovative extension approachesoriginating from multiple sources must be adopted on trial basis to make fisheries more lucrativeand sustainablewhich can be replicated in the fishery sector interwoven with numerous challengeslike increased production with sustained

natural resources, growing market demand for processed products having entrepreneurial opportunities, protection and conservation of environment, and promoting international trade.

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

a. Asset Based Community Development (ABCD) approach

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

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

Five Key Assets in ABCD

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

1. **Individuals**: Every individual has got certain assets, gifts and qualities; such individual is at the center of ABCD approach.
2. **Associations**: Groups of people working with a common interest are critical to community mobilization.
3. **Institutions**: The assets of institutions help the community capture valuable resources and establish a sense of civic responsibility.

4. **Physical Assets**: Physical assets such as land, buildings, space, and funds are other assets that can be used.
5. **Connections:**These are the exchange between people sharing their assets by various methods.

b. Rural advisory services (RAS)

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

In fishery sector, RAS helps in

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

⇨ Promoting institutional and policy change to enable and support small-scale fishery.

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

c. Model Village System of Extension (MVSE) approach

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

MVSE approach works on the following principles:

- Promotes self -governance among the fishers
- Skill improvement and leadership development among the fishingcommunity.
- Establishing linkage through pluralistic convergence of various stakeholders associated in the sector.
- Encouraging the market opportunities through commodity based village development (CBVD).

d. Farmers Field School (FFS) approach

The FFS extension approach is an alternative to the top down extension approach which was evolved as a method to solve complex field level issues in fisheries sectors. FFSaims to build

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

It is also significant to note that irrespective of the merits of the technology, the acceptance to technologies is influenced by the extension method. Farmer Field School (FFS) model has been accepted as a good methodology because it is exclusively participatory. A special feature of this extension approach was that it reached poor and female-headed households and lower-caste households much better than the regular extension services (Tiwari et al. 2010). FFS was also found to be effective in avoidingbarriers like socio-economic constraints, infrastructure problem and incompatibility of technologyfor the adoption of sustainable fishery practices.

The basic component of FFS is setting up of a Participatory Comparative Experiment (PCE), commonly referred to as Participatory Technology Development (PTD), whereby the fishersput the FFS concept into practice under close monitoring and supervision by the FFS members. A PCE can be developed in the field of agriculture, livestock, fishery, forestry, agro-forestry, livelihood system and others.

Principles of Farmer Field School(FFS)are as follows: -

- Field is the learning place.
- Emphasizes hands on and discovery based learning.
- Farmers become experts.
- Integrated and learner defined curriculum.

- Doing is better than learning/ seeing.
- Experiences are the start of all learning.
- Link to actual field situations and should be relevant to local needs and problems.
- Participatory monitoring and evaluation.
- Fishermen are decisionmakers.

e. Market Led Extension (MLE) approach

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

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

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

f. Digital Extension approach

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

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

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

The use of internet, mobile and video- conferencing assists the IT enabled farmers to utilize the facilities for their favors for which the most suitable permanent infrastructure is the basic

requirement. Strong linkages need to be established between direct ICT interventions and it should be part of the national level program on holistic agricultural development.

g. Disruptive Extension approach:

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

- Importance of good governance in agriculture (and allied fields) that considers the resource rights of the farmers.
- Emphasis on growing interest among the stakeholders by explicit analysis of field level issues for technology adoption.
- Potential to resolve the social conflicts for equal access to community resources through Memorandum of Understanding (MOU).
- Based on cost recovery mechanism.
- Ensure commitment to optimum resource management and maximum economic benefit to improve food security.
- Provision of community based social insurance.
- Maintaining the sustenance of the technology supports through custom hiring approach.
- Focus on pluralistic convergence of different partners to build a network of linkage with various entities around the farm households.
- Encouraging the farmers-scientist interaction for technology development, assessment and application through Farmers' FIRST approach.

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

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Assessment of harvest and post-harvest losses in fisheries and aquaculture

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Introduction

Indian fisheries and aquaculture is an important sector of food production, providing nutritional security to the food basket, contributing to the agricultural exports and engaging about fourteen million people in different activities. The total fish landing during 2018 was 34.9 lakh tons worth approximately Rs.57510 cores. India's marine product exports was 13.77 lakh tons earning 7.08 US billion dollars during 2017-18 which underlines the importance of the sector. Studies have pointed out that considerable harvest and post-harvest losses occur all along the fishery value chain through the various channels of distribution. Huge losses occur along the fish value chain, both in terms of quantity and quality due to discards at sea, improper handling, storage & icing, lack of cold chain facilities and delay in transportation. Reducing harvest and post-harvest fish loss will enable money saving for the primary producer, enable the sector to feed more and ease the pressure on water, land and climate. Ensuring proper cold storage facilities along the value chain, climate smart processing and packaging, value addition, technology interventions in transportation to avert spoilage can bring down post-harvest losses from 10 to 50% in the fisheries sector.

The inland fisheries covers the brackish and freshwater systems with aquaculture practiced and managed in ponds and fields connected to natural resources. The fish landing sites are numerous and remote in interior parts of the country sometimes inaccessible. Delay in transport, non-availability of ice for proper storage brings down the price of freshwater fishes in the markets which is an economic loss for the primary producer.

The resources once harvested has to be managed and utilized judiciously to derive the maximum benefit and sustain the livelihoods of lakhs of stakeholders involved along the fishery value chain. For an assessment of the extent of harvest and post-harvest losses in marine and inland fisheries at the National level, sound statistical estimates have to be computed. The changes in fisheries sector with reference to technology advancements have led to a changed definition of 'losses' which has been accepted by researchers worldwide. Therefore, assessment of harvest and post-harvest losses gains importance when formulating effective strategies for wholesome utilization of fish and fish products.

Fish losses

Loss per se is defined as the quantity of marine fish which is not fit for human consumption due to physical loss or spoilage of some other reason. Losses at the time of harvesting and onboard the fishing craft are called harvest losses and losses occurring after harvesting i.e. from the landing centre up to the consumer at different stages are called post-harvest losses. Literature classifies Post-harvest losses broadly into three categories –

- ✓ Physical loss
- ✓ Quality loss
- ✓ Market forced loss

Post harvest losses occur due to improper handling and lack of infrastructure at different points starting from the landing centre to the consumer. Apart from these, there are latent losses such as realization of low value due to glut, multi-day fishing etc.

Discarding takes place because, in the course of fishing, many species other than the target species are often caught. This by-catch is usually discarded at sea unless it is worth keeping. Discarding by-catch consisting of a small proportion of mature specimens from healthy stocks causes relatively little damage, but when it consists of juveniles of commercial species it will disturb the balance of the system. Catching large numbers of juveniles is likely to reduce the future number of mature fish. This will have a direct impact on the fishery taking the by-catch, or on other fisheries if the juveniles belong to their target species.

Apart from the loss of a massive amount of potentially valuable food, the incidental capture of dolphins in tuna purse seine nets, turtles in shrimp trawls and marine mammals, birds, turtles and fish in high-seas squid driftnets has led to widespread public concern. Unfortunately, by-catches are an inevitable consequence of an industry that depends upon the capture of species that live alongside other creatures in an opaque medium and as a result can seldom be directly observed and targeted.

By-catch arises primarily because of fishing gears and adopting practices which do not selectively target the desired size and species. The reason for discarding part of the catch is generally economic. In such cases the cost of bringing fish to market is greater than its market value and it gets dumped at sea. Similarly, where a fishing vessel has limited holding capacity, low-value species are discarded in favour of the high-value ones.Introduction of improved harvesting methods, starting from mechanization, indiscriminate increase in fleet size and number, multi-day fishing, use of unregulated mesh sizes have all led to imbalance in several forms and threatening of food security. In tropical countries, high temperatures lead to fish spoilage while still in the boat, at landing, during storage or processing, on the way to market and

while waiting to be sold. There is also considerable economic loss as value gets lost because of lower quality, including insect infestation and breakage.

Several studies have been conducted in the recent past for the assessment of extent of harvest and post-harvest losses in fisheries. As early as 1981 FAO recommended action to reduce post harvest losses in marine fisheries- estimated at that time to be 10 percent of the global total, and up to 40 percent in some developing countries.Studies were conducted at CIFT, Cochin on 'Assessment of harvest and post-harvest losses in fisheries' through a NATP funded project . The percentage loss due to harvest through traditional, motorized, mechanized and large trawlers has been put at 4.13, 3.61, 14.48 and 21.41 respectively within the craft/gear (Anon., 2005). The study has also assessed post-harvest losses in fisheries in different channels viz., market, pre-processing and processing and reported the percentage loss through each of these channels. Losses can be physical, economical and nutritional and can be minimized by adopting suitable post-harvest technology (Johnson and Ndimela, 2011).

Ahmed (2008) has assessed post-harvest losses of fish in Sudan with special emphasis on cultural and socioeconomic aspects including traditional food conservation; economic factors for food conservation and cost-benefit; assessment of the effect of globalization and liberalization of food markets and the fish trade in artisanal fisheries. Ward, A. (1996) developed methods to quantitatively assess post harvest fish losses and to understand and identify the causes in qualitative sense. Adams, (1995) advocates Individual Fishing Quota (IFQ) system where fishermen can be selective about factors as fishing depth, bottom substrate, or time of day, month or year. These factors are directly related to incidental halibut by catch mortality. Clucas, et. al. (1989) reported 20% post harvest losses of annual fish production of about 13.5 lakh tonnes by 16 ECOWAS countries of West Africa. Similar figures were observed in the artisanal fisheries sector that contributes about 90% of the total catch.

Estimation of losses in fisheries

A recent study completed at CIFT, Cochin attempted to estimate harvest and post-harvest losses in marine fisheries. Ernakulam and Alleppey districts were covered for the study. The estimation was carried out at the two stages harvest and post-harvest stages using stratified random sampling design. The channels of fish production namely mechanised, motorised and traditional formed the various strata at the harvest stage, In the post havest stage, losses occurring at landing centre, processing, marketing and transportation sectors were observed. The study was conducted for a full fishing season to observe loss pattern during monsoon, pre-monsoon and post-monsoon seasons. Around 1 to 3% sampling was done in the harvest stage whereas for the post-harvest study, the samping done was from 10 to 30% for the various channels.

In the processing channel, the pre-processing centres and fish processing centres in Ernakulam and Alleppey district were covered by using of a sample. The losses occurring in marketing

sector was studied in the wholesale markets, retail markets, roadside markets were covered for the study. The dryfish production and marketing channel was also studied by means of a sample for recording losses occurring in the dryfish sector. The estimates were computed using methodology derived by IASRI for loss estimation (Anon., 2005).

Harvest losses in marine fisheries was estimated from Ernakulam district by stratifying fishing crafts into mechanized, motorized and traditional. Primary data on fish catch and losses was collected for 12 months from fishing crafts operating in six selected fish landing centres at Ernakulam. Loss estimates were computed analyzing the season wise data and pooled data. The sector wise harvest loss estimates are as under :

Harvest losses

Sector	Pre-monsoon (%)	Post-monsoon (%)	Monsoon (%)	Overall (%)
Traditional	1.93 (0.43)	0.98 (0.37)	0.83 (0.28)	1.14 (0.28)
Motorised	3.45 (0.54)	2.76 (0.13)	4.38 (0.53)	3.65 (0.17)
Mechanised (upto 7 days fishing duration)	12.74 (1.23)	11.09 (0.11)	9.11 (0.05)	14.15 (2.10)
Mechanised (more than 7 days)	13.78 (1.24)	14.98 (1.35)	13.35 (1.32)	18.73 (2.22)

Multiday fishing by the mechanized trawlers reported maximum loss due to capture of juveniles and their discards. Around 1500 to 2750 kg of fish gets discarded at sea by trawlers during fishing trips for more than 7 days duration. The no. of hauls during fishing and loss was positively correlated (0.69) at 5% level of significance. The estimate of loss due to mechanized fishing was computed by utilizing information on no. of hauls which was more precise than the traditional estimator. The losses due to motorized fishing crafts was very less in comparison with trawlers. The traditional fisheries sector reported minimal or no loss during the period.

Post-harvest losses

The post-harvest losses in marine fisheries (at the landing centre level) was estimated as below :

Sector	Loss % (SE)
Traditional	0.09 (0.0004)
Motorised	1.19 (0.07)
Mechanised	4.79 (1.09)

The loss estimates when compared with the estimates brought out by earlier studies indicate that the post-harvest losses have come down due to efficient handling of catch. The post-harvest losses in processing and marketing sector was also computed from Ernakulam-Alleppey during the period under report. For reporting loss in processing sector, 50 pre-processing units and 25 processing units were observed and data on raw material processed and loss were recorded fortnigh tly. Shortage of ice and spoilage were cited as the reasons for loss in pre-processing. At the processing stage, losses occurred due to discolouration, broken tentacles, black spot and at time loss during glazing. Few units reported rejections at export destination due to heavy metal detection.

Losses in the marketing sector was due to damage during transportation, spoilage when delay in transport and weather. Two wholesale markets for fresh fish and one wholesale market for dry fish were covered fortnightly for recording losses due to marketing. Similarly 4 retail markets were surveyed fortnightly of reporting loss in retailing fish. The estimates for post-harvest losses due in processing and marketing are given below :

Post-harvest losses in marine fisheries

Sector	Loss % (SE)
Pre-processing	0.38 (0.04)
Processing	1.19 (0.07)
Dry fish production	36.97 (12.88)
Wholesale market (fresh)	3.79 (1.09)
Wholesale market (Dry)	7.56 (2.12)
Retail market (fresh)	3.13 (0.02)
Retail market (Dry)	8.23 (0.13)
Roadside market (fresh)	2.54 (0.11)
Roadside market (dry)	5.43 (1.19)

The reasons for losses were also recorded along with the loss details.

Harvest losses were mainly due to i) Fish fall from netii)Bruising due to handlingiii) Fish spends too long in the net and gets spoilediv) Lack of ice / Chilling causing spoilage

The reasons for post-harvest losses -

At landing centre the post harvest losses occurred while (i) loading for transport, (ii) kept in the beach without sufficient ice. During the processing of fish when there is a low capacity in the plant fish procured for processing gets spoiled leading to losses. Also adverse weather conditions while drying and insect infestation lead to post-harvest losses

The reasons for post-harvest losses during transport, storage and marketing are listed as under :

Transport

i) Mechanical damage
ii) Delay in transport

Storage

i) Poor storage
ii) Insect infestation

Market level

i) Insect infestation
ii) Packaging
iii) Mode of transport
iv) Handling

A look at the loss estimates reveal that the fish loss in the mechanised fishing sector is more compared to the other sectors. Multi-day fishing leads to larger volume of discards at sea which has inflated the estimates. Use of stipulated mesh sizes to avoid juvenile fishing, use of by-catch reduction devices, utilisation of low value fishes for innovative product development and waste utilisation for production of fish based feed and manure will help reduction in harvest and post-harvest losses in fisheries. Training and awareness programmes on the responsible fishing methods developed by CIFT among the merchandised fishermen will check discards at sea. Under NAIP value chain project at CIFT, Cochin a number of innovative technologies for value addition from low value fishes were developed and demonstrated as viable business models for adoption by coastal fisherwomen. Popularization of these technologies along the coastal belt will enhance the income and livelihood of the fisherfolk.

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Prospects of Micro-financing in Fisheries Sector

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Unless all the discoveries that you make have the welfare of the poor as the end in view, all your workshops will be really no better than Satan's workshops.

- Mahatma Gandhi

The major challenges to any developing society are poverty and economic deprivation of its rural population. Eradication of poverty, the focus of all developmental efforts, has remained a very complicated and serious concern for all developing countries. Poverty is rooted in different interconnected factors such as lack of ownership of assets, unemployment, low remuneration, illiteracy, social & geographic disadvantages etc.

The rural areas were reported to be more prone to poverty and are continuing to be poor as they fall as victims of the "vicious cycle of poverty" due to some inherent issues. Fishing communities in the coastal belts all over the world are also not an exception to this. Poverty in fishing communities is very common and is characterized by high population density, poor living conditions, lack of proper education and poor access to education and health care. Due to poor attention paid by the state, the status of infrastructure support like roads, electricity, good drinking water, markets etc also are poor. Though efforts for reducing fishing pressure is taken by Government, scope for alternative employment opportunities are less, which again aggravate the economic situation of the sector. Thus the sector that is engaged in the world's most risky occupation and contributing to country's GDP, is still on par with SC/ST communities as far as India is concerned. The loss of a boat, gear or an active fisherman in the family can be tragic and lead to total financial deprivation of the family. Poverty and vulnerability in fishing communities are widely known but poorly addressed issues. As in rural farming sector, dependence of fishing communities on private moneylenders continues in many areas, especially for meeting emergency requirements. For various reasons, credit to these sections of the population has not been institutionalized.

The emergence of microfinance as an alternative financial delivery mechanism was a solution for the failure of past efforts taken by government and non-governmental agencies to effectively provide financial services to the poor. Instead of random payment of loans to target sectors and populations, efforts were taken for setting up and building local institutions that cater for the poor. This resulted in the materialization of microfinance institutions (MFIs) that serve the rural poor. MFIs initially started providing microcredit but have now extended their services to savings, insurance etc.

What is Micro Financing?

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

Micro Finance Institution, also known as MFI, is an organization that offers financial services to low income populations. These organizations give loans to their members and many offer insurance, deposit and other services. **Microcredit** is the extension of very small loans (microloans) to impoverished borrowers who typically lack collateral, steady employment and a verifiable credit history

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

The microfinance system basically involve three levels: the borrowers ii) the loan distribution and recovery system and iii) the institution or organization that operates the financing system.

The successful operation of these levels is based on the client's commitment, to make prompt payment of the amount received under MFI; and institutional discipline where MFIs are offered which have quality, efficiency and commitment. There are individual and group-based approaches. Individual lending is giving credit to individuals who are not members of a group that is jointly responsible for loan repayment. As it is documented and asset-based, lending is provided to individuals based on their ability to give the MFI assurances of repayment and some form of collateral, or a willing co-signer.

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

Micro banking –Indian context

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

The major types of microfinance involving credit linkages with banks in India are (i) SHG - Bank Linkage Model: This model involves the SHGs financed directly by the banks viz., CBs (Public Sector and Private Sector), RRBs and Cooperative Banks. (ii) MFI - Bank Linkage

Model: This model covers financing of Micro Finance Institutions (MFIs) by banking agencies for on-lending to SHGs and other small borrowers.

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

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

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

The scope of extending micro finance to fishing communities is already explored in India and has found fruitful in the past few years. But still, micro finance programmes for fisheries sector should be given special considerations that are unique to fishing communities. The scattered attempts are to be further extended and scaled up at national level, for which efforts are on the way.

Who are providing micro finance?

Microfinance providers can be classified as formal financial institutions, semiformal institutions and informal providers. Formal financial institutions are subject to banking regulation and supervision and include public and private development banks and commercial banks, among others. Semiformal financial institutions, notably NGOs, credit unions and cooperatives and

some SHGs, are not regulated by banking authorities but are usually licensed and registered entities and are thus supervised by other government agencies. Informal providers are those entities that operate outside the structure of government regulation and supervision.

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

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

Principles of financially viable lending to poor entrepreneurs

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

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

Principle 2. Streamline operations to reduce unit costs

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

- Select staff from local communities

Principle 3. Motivate clients to repay loans

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

Joint liability groups. An arrangement whereby a handful of borrowers guarantee each other's loans is by far the most frequently used repayment motivation. Individual character lending can be effective when the social structure is cohesive

- *Incentives.* Guaranteeing access to loans motivates repayments, as do increases in loan sizes and preferential pricing in exchange for prompt repayment. Institutions that successfully motivate repayments develop staff competence and a public image signalling that they are serious about loan collection

Principle 4. Charge full-cost interest rates and fees

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

Some more points to take into account are given below:

- As seasons play a critical role in the success of capture fisheries and fish farming, the availability of credit should be assured in time. Also, as capture as well as culture fisheries are occupations requiring **fairly good level of skill, required training and technical guidance** are crucial for the success of their endeavours. The organisations involved must take a note of these points also to enable the fisherman succeed in his venture and repay the loan in time.
- A thorough understanding of the **socio-cultural context** in fishing communities is made more critical in microfinance because it requires strong social bonds among the borrower groups to enforce discipline to repay loans.
- Analysis of different **socio-economic subgroups** in fishing communities, to identify the subgroups most in need of financial services to support their enterprises
- It is highly relevant to study important **demographic and socio-economic changes** have taken place in recent years in coastal fishing communities
- As income is not regular or uniform from both capture and culture fisheries, an estimation of the **market size for microenterprises and their products** must be made to ensure that enough demand for financial services exists, thereby ensuring the long-term sustainability of microfinance operations.

- Preference should be for those who already have identified or **existing microenterprises** but who need financial services, either to expand or build up their asset base, compared to those planning to start from scratch
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- Globally, **women constitute the majority of microfinance clients**, primarily because of their better repayment records. This also makes them a particular target group for microfinance activities in fishing communities. It is recognized that women play an important role in fishing communities, encompassing social and economic responsibilities and duties, both within and outside their households. Women are more involved in land based trading/vending, processing and marketing activities to generate continuous earnings to make up for the seasonal nature of their husbands' incomes. Loan size requirements are small, which makes them appropriate clients of microfinance.

- World over, it is an accepted fact that **subsidized interest rates are not financially sustainable**. Therefore, a balance between a market-based interest rate regime that allows the MFIs to cover all their costs on the one hand and what the clients can afford and what the market will bear, on the other, must be reached

- Successful group-based lending usually **starts with small loans, gradually increasing** based on repayment history. The guiding criteria for both fishery and non-fishery based projects should be the viability and profitability of the chosen economic activities.
- For most MFIs, repayments are made on an instalment basis (**weekly, bi-weekly, monthly**) for activities that generate ongoing revenues. In fishing communities, this would be appropriate for fish marketing and trading projects. For **seasonal activities**, such as in aquaculture and fish farming, where expected revenues are realized at harvest time, lump sum payments would be appropriate.

There are two kinds of savings services provided by MFIs: compulsory and voluntary savings. Compulsory savings are funds contributed by borrowers as a condition for receiving a loan. Voluntary savings operate on the principle that the poor already save and only require appropriate institutions and services to meet their needs. (Uwe Tietze and Lolita V. Villareal 2003).

Conclusion

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

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

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Establishing Fish Based Enterprises for Livelihood Security: Scopes and Opportunities

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The basic reason for poverty is not nothingness..... It is the tendency of unwillingness of human mind for sharing the available, inability to make use of opportunities effectively and lack of willpower.....Technology for a micro-enterprise is a 'game' for the rich, a 'dream' for the poor and a 'key' for the wise……(Kudumbashree, Kerala State Poverty Eradication Mission)

It is an unequivocal proposition that, fisheries sector occupies a paramount position in the socioeconomic development of our country. Fisheries, aquaculture and fish based enterprises are considered the sunrise sectors in India, providing nutritional security, contributing to the nation's GDP and offering employment to over 14 million people directly and indirectly. Constituting about 6.3% of global fish production, the sector contributes to 1.1% of the GDP and 5.15% of the agricultural GDP (NFDB, 2016). The extent of inland water resources of India prevailed hovering potential considering aquaculture-entrepreneurship development. In fisheries sector the input production and the input-delivery-systems like fish production, marketing and exports, processing and product developments needs emerging entrepreneurs.The professionals in the government sector cannot take up all the responsibilities in order to bring quantum change in the system. There exists a variety of initiatives around the globe by the individuals and institutions, involving in missions of philanthropic nature, which try to create viable and sustainable changes in person's lives. Social entrepreneurship will be demanded to replace the existing aquaculture practices of India with more sustainable resilient practices and management strategy. This is one of the major lacunae of entrepreneurship development in fisheries sector. But according to Kahan (2012), farmers see their farms as a business and as a means of earning profit and thereby ultimately to bring about development. It would be pertinent to have a look into the scope and opportunities of fish based enterprises for livelihood security of fisherfolk in the chain of development.

The word development means the upliftment in the standard of living of the poorest of the poor in the society. Development of Indian fisheries sector in a broader visualization will be materialised with poverty eradication programmes though the transparent media namely Self Help Groups. Self Help Groups can play a vital role for the fisheries sector development. The utmost important requisite for this is ensuring participation of fisherfolk especially women in the planning and implementation of various coastal sector development progammes.Alternative livelihood options through appropriate and economically viable micro enterprises are the only solution for meeting the ever-increasing demand of population in coastal belt in the context of

diminishing per capita fish catch. The means of livelihood of coastal fisherfolk in different maritime states vary from one another. Since the livelihood conditions and technological requirements of the fishing population have not been studied in depth, it is difficult for any technological intervention and implementing other management options for improving the livelihood status of the fisherfolk. An attempt is made for developing a theoretical framework based on the review of past research studies related to livelihood analysis both at national and international level.

A couple of reviews in the National Level:

Livelihood analysis indicates the way in which the farmers belonging different category of wealth make their livelihood including the crisis management. (Sabarathnam 2000) Viswanathan*et al* (2002) informed that fisheries in developing countries are under intense pressure from increasing coastal populations, over exploitation of resources and conflicts over access to degraded livelihood resources.This is one of the techniques of Participatory Rural Appraisal (Bhat,2003) for an expeditious analysis of the rural situation to plan and act. Livelihood analysis of coastal fisherfolk in any region is inevitable for the appropriate micro enterprise selection for the location for empowerment. (Kurien, 2003). Similarly several micro and macro level socioeconomic studies had been conducted by various agencies and research workers in different regions of our country on the livelihood problems of fisherfolk. (Srinath 1987; Sathiadhas and Panikkar,1988; Aujimangkul*et al*, 2000). The generalized objectives of such socio-economic studies stress on the assessment of human resources of identified geographical location, features of the target groups of specific developmental programmes, poverty, hunger, mal-nutrition and health status of fisher households, impact of introduction of new technologies and practices on income and employment, alternate fishing strategies and mariculture practices, infrastructure facilities and potential for development, rural indebtedness and supply of credit by various agencies, inter and intra structural conflicts in harvesting and post harvesting activities of marine fisheries, role of women in small scale fisheries sector, feedback information from the field to revise the strategy or devise to follow up action etc. Gender based studies and impact microfinance and SHGs also gained significance to a great extent in the present topic of discussion. (Vipinkumar et al, 2013)

A short glimpse of reviews in the International Level :

Livelihoods are attracting increasing attention in the context of Community Based Coastal Resource Management (CBCRM). The livelihood analysis encompasses all the strategies and assets that individuals and households use to earn a living (DFID, 2001; CBCRM Resource Center, 2003; Graham and Tanyang, 2001; Arciaga*et a*l, 2002; Ashby, 2003). This definition is extremely broad, and its implications and local understanding of the term can only be understood through context specific participatory research and dialogue. There are three specific areas where livelihoods connect directly with CBCRM initiatives and all have relevance. First of all, from a livelihoods perspective, natural resource use by an individual or a group of people is part of their

livelihood strategy. "A reversal of environmental degradation require new livelihood options that change people's incentives, in particular the benefits and costs of resource use" (Ashby, 2003; p2). Many livelihoods in coastal communities are based on the sea, therefore resource management activities, such as those commonly carried out through CBCRM initiatives, are livelihoods activities that reduce local vulnerability and enhance natural capital (Graham and Tanyang, 2001; Arciaga*et a*l, 2002, Vipinkumar*et al*,2015, 2017).

Some general observations in Fisheries sector

Generally in fisheries sector, because of the lack of saving tendency, whatever the fisherfolk earn are being spent. Nothing is generally left for tomorrow. Entire family may starve unless he goes for fishing. While becoming sick, they may depend on private moneylenders for sustenance, food and medicine. If he falls in the trap of huge interest, the major potion of his earnings will be for paying interests. If the repayment is obstructed, the interest amount will grow bigger than the amount borrowed. The debt may transfer to the subsequent generations also. The formal financial organsiations and banks are even at present unapproachable to these poor fisherfolk.It is not due to lack of interest that the fisherfolk don't save anything, but it is the lack of opportunity to save, which becomes the major obstacle preventing them from saving something. Even if they are interested in savings, there are a lot of obstacles to deposit in banks. For opening an account, another person possessing account in the bank has to introduce. Photographs and identity documents are required. Similarly, he has to remit a fixed amount to open an account. In addition to this, he has to forgo / sacrifice one day's labour for this purpose. Here comes the relevance of Self Help Groups.

Relevance of Community Cohesion and Self Help Groups

There are a couple of differences between savings and thrift. Savings is the balance amount from expenses out of total earnings. But for the poor income groups, expenses are more than earnings. Therefore, savings will be meager. Thrift is just like an item of expenditure compulsorily kept aside for future use and is not the balance from earnings. This is strictly kept apart. In olden era, a handful of rice kept apart every day when gets accumulated was being used during off seasons for sustenance. Thrift is just like that. A few women fisherfolk when mobilized as a group, members can contribute the fixed nominal amount as thrift in every week in the group meetings. This collective amount can be deposited in banks as joint account the very next day. Slowly this thrift amount gets grown to a considerably big amount Say for example, 25 members in an SHG when collect Rs 20/- each every week as thrift, it becomes Rs 500/- in the first week. It will be Rs 2,000/- in the first month and Rs 12,000/- within 6 months. As the thrift collection regulates the judicious spending habit among members, economic discipline in the SHG will be easily feasible. After 6 months of initiating the thrift collection, the members for the Self Help Groups can be given loan for their emergency expenditure at a nominal interest rate. The members themselves can decide the norms for the credit. Since the SHG members are

known to each other, the needs can be prioritized as per their importance / significance and it meets the essential requirements of the members throughout 24 hours just like an informal bank in front of their house. The members will decide the duration of loans and interest particulars. By solving the problems of the SHG members on group basis the skills and ability of the members in handling financial matters get enhanced and the group slowly gets led to Self Helping Stage.

For undertaking some income generation activities for the members, a suitable micro enterprise is to be found out for the Self Help Group and then SHG can be linked to other financial organizations like NABARD, *Rashtriya MahilaGhosh*, other banks etc for availing better credit facilities. The savings of the SHG when gets deposited in formal banks, there commences the relationship with the financial organizations. Since the welfare of the SHG naturally becomes the responsibility of the banks also, they actively involve in further activities, growth and progress of the SHG. Banks give loan assistance without supporting documents to SHG and in turn the SHG gives it to the members.

An SHG which functions as thrift-credit group for a minimum period of 6 months, can avail double of the thrift amount as loan from well- established financial institutions, The increase in thrift amount and punctuality in repaying the loans make these SHGs' deserve multiple times of thrift amount as loan further based on the norms of the institution. There are a lot of other financial organizations giving loans to SHGs'.Experiences and observations indicate that, for a group to be developed as a Self Help Group, normally a period of 36 months (3 years) will be required. Within this gestation period when the group passes through three distinct phases, up to 4 months as the Formation Phase, up to 15 months as Stabilisation Phase, and up to 36 months as the Self Helping Phase, the group gets led to the stage of a flourishing Self Help Group as per the indications given by social research results on Self Help Groups.The fisheries Self Help Groups have to focus attention on joint efforts co-operatively for finding out suitable micro enterprises, which can assure a constant income for the fisherfolk, based on locally available resources for poverty eradication.

What is a micro enterprise ?

A micro enterprise is an activity which requires less capital, less manpower, local raw materials and local market. It is an individual enterprise whether known or unknown. (Vedachalam,1998).In fisheries sector, for the upliftment of fisherfolk below the poverty line, some successful micro enterprises developed based on the location specific resource availability and experience and some alternate avocations and subsidiary entrepreneurial ventures successfully being undertaken by Self Help Groups in coastal sectors and allied areas as follows :

Value added fish producing units, Dry fish unit, Fish Processing unit, Ready to eat fish products, ready to cook fish products, Ornamental fish culture, Mussel culture, Edible oyster culture, Clam collection etc. are very important.In agricultural sector, Vegetable cultivation,

Ornamental gardening, Floriculture, Kitchen Garden, Orchards, Fruit products, Fruit processing, Sericulture, Mushroom cultivation, Medicinal Plants, Vermi compost, Snacks units, Catering Units, Bakery Units, Cereal Pulverizing units are some micro enterprises undertaken by Self Help Groups.

Based on the resource availability and circumstances the micro enterprises those the SHGs' can generally bring to practical utility in allied sectors are Wood work units, Stone work units, Soap units, Garment units, Computer centre, Poultry centre, Cattle rearing, Piggery unit, Bee Units, Stitching units, Hand Weaving Units, Candles, Chalks, Umbrella units, Foam Bed Units, Bamboo based handicrafts, Paper cover, Scrape selling, Vegetable seeds, Marriage bureau, Medicine collection, Patients service, Real estate, Medicine processing, Direct marketing, Coir Brush, Plastic weaving, Second sails, Meat *masala*, *Rasam* powder, Curry powder, Pickle powder, *Sambar*powder, Consumer service centres, Home delivery package, Repacking business, Cleaning powder, Phenol lotion, Liquid soap, Washing soap, Toilet soap, Kids' garments, Toffee & Sweets, Photostat, Washing powder of best quality and medium type, Emery powder, Domestic animals, Nursery plants, Note book, Book binding, Rubber slipper production, Pillow cushion, Incense stick production, Cloth whiteners, Eucalyptus oil, Dolls, Hand shampoo, Soap shampoo, detergent shampoo, Jackfruit jam, Chips, Hotel, Catering service, Grape wine, Pineapple wine, Soft drinks, Chicken farming, Dried mango wafer, Dried chilli, Gooseberry wine, Ginger wine, *Pappads*, Tomato sauce, Day care centre, Coconut water vinegar, Syrups, Artificial vinegar, Mixed fruit jam, Milk chocolate, Tomato squash, Gum production, Cleaning lotion, Soft drink shop, Reading room, Private tuition, Counseling-guidance, Rent sales, Paying Guest service, Repairing centre and handicrafts are some of the employment opportunities that the SHGs' can venture throughout Kerala depending on the suitability of situations and availability of resources.

The suitability of the enterprise varies from situation to situation. The essential features for the success of a viable micro enterprise are :

1. The availability of sufficient quantity of raw materials locally.
2. The identified enterprise is known or easy to learn and practice.
3. The cost of production must be low.
4. The products must be of very good quality.
5. The availability of market for the products.

The important financial organizations giving financial assistance to SHGs' are Khadi Village Industries Board, Department of Commerce & Industry, *JawaharRosgar Yojana*, Women Industrial Cooperative Societies, Kerala State Social Welfare Advisory Board, Kerala Financial Corporation, National bank of Agriculture and Rural Development, District Rural

Development Agency, Other Non Government Organizations, *Kudumbasreeayalkoottam*groups etc.

A case study undertaken on preference of fisherfolk by ranking of priorities forsome selected viable micro enterprises in fisheries, agricultural and allied sectors in Milkatkar and Navgav locations of Alibag district in Maharashtraare presented Table 1. Technology status and technology needs were prioritized and ranking of priorities based on the Rank Based Quotient (RBQ) on fishery based micro enterprises was in the order as Preparation of value added products, fish processing, dry fish products, mussel culture, ready to eat & ready to cook fish products, ornamental fish culture, and edible oyster culture. With regard to Agriculture based micro enterprises the ranking was in the order of Kitchen garden, Vegetable Cultivation, Planting mangroves and acacia trees, Catering units, Cereal Pulverizing units, Ornamental Gardening enterprise etc. With regard to allied sector micro enterprises, the ranking was in the order of Cattle unit, Poultry unit, Bamboo based handicrafts, Wood – Stone carpentry, Computer centre, Candle unit, Chalk Unit, Umbrella Unit etc.

Table 1 : Ranking for priorities of women fisherfolk for the technology needs/ micro enterprises in fisheries sector based on the suitability of location

No	Fishery based micro enterprise	Rank
1.	Preparation of Value Added products in Fisheries	I
2.	Preparation of Dry Fish products	III
3.	Fish Processing Unit	II
4.	Ready to eat fish products	V
5.	Ready to cook fish products	VI
6.	Ornamental Fish culture enterprise	VII
7.	Mussel culture	IV
8.	Clam collection	IX
9.	Edible oyster culture	VIII
10.	Pearl culture	XII
11.	Mud Crab culture	XI
12.	Any other	-

Agriculture based micro enterprise		
1.	Vegetable cultivation	II
2.	Ornamental Gardening enterprise	VI
3.	Floriculture	VII
4.	Kitchen garden	I
5.	Orchards	XII
6.	Fruit products	VIII
7.	Fruit Processing	X
8.	Snacks bar	IX
9.	Catering Unit	IV
10.	Bakery Unit	XI
11.	Cereal Pulverizing Unit	V
12.	Sericulture Unit	XIII
13.	Any other : Planting mangroves & acacia trees	III
	Allied sector micro enterprises	
1.	Soap unit	X
2.	Clothes unit	XI
3.	Garments	XII
4.	Wood – Stone carpentry	IV
5.	Computer centre	V
6.	Cattle unit	I
7.	Poultry unit	II
8.	Hand weaving	XIII
9.	Candle unit	VI
10.	Chalk Unit	VII
11.	Umbrella Unit	VIII

12.	Foam Bed Unit	IX
13.	Bamboo based handicrafts	III
14.	Firewood	XIV

Certain important facts will be revealed as the consequences of Coastal Zone Development when gets practically materialized through SHGs'.

- Since the empowered SHGs' assist the members by undertaking thrift-credit activities through own savings and loans from banks though suitable micro enterprises, they adequately earn and make the members capable to stand in their own legs.
- Since the problems faced by the members are being presented and resolved on consensus every week, in the SHG meetings, they become able to exist with extreme protection feeling and mental health built by wholeheartedness developed through this coordination.
- Women's savings have a profound influence on the family safety and set up. The self-confidence that they can also work for the welfare of their family can be built up through these Self Help Groups.
- Since the SHGs' meet every week, all the members get a very good grasp about the beneficiaries in the respective locality and thereby making the election process of beneficiaries very transparent.
- The beneficiaries can be persuaded to utilize the eligible benefits for the purposes for which those were intended.
- Self Help Groups created a remarkable change in the social responsibility feelings for the fisherfolk. The incidents in which certain women SHGs' significantly contributed to the disaster relief funds are the clear-cut examples of the transformations created by economic empowerment.
- Irrespective of the political / religious restrictions, the ways by which Self Help Groups started taking lead role in cultural activities like celebrating special days, organizing common action programmes with involvement of cultural leaders, conducting arts and games competitions and literacy classes etc. are the examples of social responsibilities of Self Help Groups.
- These SHGs' as the symbol of 'collective cooperation' can function as an informal bank in front of home, a genuine friend in emergencies, a protector from exorbitant interest for loans etc.
- Based on the thrift deposits generated by an SHG, constituted with exact norms and standards, clear cut rules and regulations, the fisherfolk can come forward to identify suitable income deriving micro enterprises with the effective utilization of loans available from banks and other financial institutions and thereby escape from the 'permanent debt trap' for ever.

From the light of experiences, it can be stated undoubtedly that, by solving common problems of coastal sector such as literacy, drinking water, lack of health and sanitation, housing/ shelter with extreme cooperation and commitment, the fisherfolk can improve the 'local economy' of the SHG and progress towards prosperity through empowerment of SHGs' based on participation.

Impact on Gender & SHG based fishery enterprises for livelihood security in Coastal India

Similarly in another research study on Gender mainstreaming and impact of SHGs emphasized on selected 750 'Self Help Groups' in Gender mainstreaming in marine fisheries sector, an assessment of the level of performance and extent of empowerment through appropriate indices of measurement from 25 nos. of fishery based micro enterprises from Kerala, Karnataka, Tamil Nadu, Andhra Pradesh and Odisha was undertaken. In this study, identified the relevant fishery based and allied sector micro enterprises catering to the location specific needs of the SHG members and imparted 45 Entrepreneurial Capacity Building (ECB)Training programmes on the identified micro enterprises by appropriate HRD intervention programmes and organized 120 fisherfolk interaction meets. Data were gathered with standardized protocols, scales and indices developed in Mararikkulam, Thannermukkam, Kumarakom, Vadakkekkara, Vallikkunnu and Kasaba in Kerala, Bengare, Surathkal and Ullala villages of Dakshina Kannada district in Karnataka and Pampan, Rameswaram, Thankachimadam and Mandapam locations in Tamil Nadu and Arakuda and Astaranga villages in Puri district of Odisha for standardization.In Andhra Pradesh, farmer interaction meets and video documentation were conducted for women SHGs of Bandarvanipetta of Sreekakulam district, Chinthappaly of Vijayanagaram district and Pudimadakka, Lawson's bay and Jalaripetta of Visakhapatnam district assessed the impact of SHGs.Documented 200 success cases on ECB of SHGs with special reference to gender perspective. Brought out 20 movies as Gender Mainstreaming series on Impact of SHGs, (Table 2) one book on, Gender Mainstreaming and Impact of SHGs in Marine Fisheries Sector and one Interactive Multimedia on Gender Mainstreaming and SHGs: A cyber extension package.

Table 2: Fishery based Enterprises and details of SHGs covered are given in Table

Sl. No	Enterprise	Number of SHGs	Avg. Level of Performance	Avg. Empowerment Index
1	Fertifish unit	15	72.75	0.82
2	Chinese dip net	10	79.16	0.89
3	Aqua-tourism	8	78.92	0.88
4	Fish Aggregating Devices	10	79.95	0.89

5	Hand picking fishing unit	15	50.11	0.65
6	Clam processing	75	56.33	0.67
7	Pickling unit	75	72.26	0.83
8	Fish drying	60	69.95	0.78
9	Dry fish & fresh fish procuring	45	79.53	0.87
10	Fish vending /selling	70	69.16	0.78
11	Mussel culture	50	75.95	0.84
12	Prawn culture	30	59.61	0.69
13	Quarry fish culture	16	78.75	0.89
14	Cage farming	27	72.23	0.82
15	Ornamental fish culture	49	63.5	0.74
16	Fish culture	30	65.5	0.76
17	Paddy cum fish culture	30	74.91	0.83
18	Seaweed farming	30	77.63	0.86
19	Fish Amino units	10	75.35	0.84
20	Ready to Eat Fish Products	15	74.36	0.83
21	Ready to Cook Fish Products	20	71.35	0.81
22	Crab Processing	15	68.34	0.77
23	Aquaponics	5	70.21	0.61
24	Bivalve collection	30	69.16	0.77
25	Fish feed production	10	59.25	0.61

Whatever the enterprise may be, the selection or identification of the fishery based micro enterprise is the crucial and major deciding factor according the technical viability and economic feasibility. It varies from time to time, from place to place, from situation to situation and from

occasion to occasion. The economic feasibility analysis of these enterprises representing the indicative economics such as profitability, B:C ratio, Market Potential, Break Even Point, Pay Back Period etc. have been worked out through Business Plans developed under the project and these business plans can be used as a practical manual for implementing the appropriate fishery microenterprise based on the scope and opportunities. (Vipinkumar*et al*, 2017) This paper is a pertinent effort to make an overview of some viable micro enterprises through community participation and Self Help Group mobilization for rural livelihood enhancement, particularly in the fisheries sector and an analysis of livelihood options of fisherfolk. Paper also focuses on rural mobilisation through Self Help Groups as an inevitable requisite for poverty eradication in a developing country like India. How a meticulously mobilized SHG with an appropriate micro enterprise in fisheries, agricultural or allied sectors can progress towards prosperity within a short span of time is also depicted. A study undertaken on livelihood analysis showed the priorities on fishery based, agri-based and allied sector based micro enterprises based on the preferential ranking as per suitability. These prioritized micro-enterprises identified based on the suitability of the SHG through livelihood analysis in turn can bring about a desirable impact on technological empowerment in the coastal fisheries sector to a great extent.

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Social Responsibilities for Entrepreneurship Development

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Introduction

Most often, the terms businessman and entrepreneur are used interchangeably by people due to the misconception that they carry the same meaning. In the long run, an entrepreneur becomes a businessman, but there are differences. An entrepreneur is a person who brings his unique idea to run a start-up company, whereas a businessman is a person who starts a business on an old concept or idea. A businessman is oriented towards profit; however, an entrepreneur is focused on people and gives more importance to its employees, customers, and the public (Surbhi, 2015). As defined by a successful entrepreneur, "An entrepreneur is someone who mixes passion, innovation, and drive to turn a vision into a working business." An entrepreneur is a visionary who sees obstacles as opportunities. Entrepreneurs have contributed significantly to the world's society, economy as well as human kind through job creation, utilization of business opportunities and product innovation (Majid & Koe, 2012).

However, an entrepreneur is traditionally viewed as a profit maker and a calculative individual, contrary to the innovative and intuitive personality, offering products and services which bring about a change in the world. Hence, as it applies to business, entrepreneurs also should also concentrate on developing businesses with a positive relationship to the society in which they operate by taking care to balance profit-making activities with activities that benefit society. This obligation of an organization's management towards the welfare and interests of the society is termed as its social responsibility. Social responsibility often referred to as corporate social responsibility or CSR is a form of self-regulation that businesses adopt as a part of their corporate conscience and citizenship (Scilly, 2017). Corporate social responsibility refers to a method of running a company that seeks to address not only profitability, but also the environmental and social consequences of the business (Dontigney, E, 2017). Protecting the environment is one aspect of social responsibility; another is making an effort to address social problems such as poverty and hunger. A business' social responsibility also is expressed through its ethical standards -- how it treats its various stakeholders, including vendors, employees and customers (Hill, B., 2017). In sustainable entrepreneurship, business activities are utilized to solve problems, and profit making becomes a means, not an end in itself with the business created. Social entrepreneurship is the use of the techniques by start up companies and other entrepreneurs to develop, fund and implement solutions to social, cultural, or environmental issues. Environmental discontinuities such as pollution, land degradation and

climate change are examples of effects from entrepreneurial activities in the society (Chick, 2009).

Protecting the environment is one aspect of social responsibility; another is making an effort to address social problems such as poverty and hunger. A business' social responsibility also is expressed through its ethical standards -- how it treats its various stakeholders, including vendors, employees and customers.In general, social responsibility is more effective when a company takes it on voluntarily, as opposed to being required by the government to do so through regulation. Social responsibility boosts company morale, and this is especially true when a company is able to get buy-in among its employees and actively engage them in its social cause. The International Organization for Standardization (ISO), emphasizes that the relationship to the society and environment in which businesses operate is "a critical factor in their ability to continue to operate effectively. It is also increasingly being used as a measure of their overall performance (Investopedia).

Types of social responsibility in Business / Enterprises

1. **Economic Responsibilities**
   First and foremost responsibility of an enterprise is its economic responsibility, primarily concerned with generating a profit. Without profit, the enterprise cannot satisfy its employees and cannot take care of the social responsibilities.
2. **Legal Responsibilities**
   Most important social responsibility of an enterprise is the legal responsibility, which starts at the planning stage to establish the company, ensuring that it obeys all laws related to security, labour, environment and even criminal law.
3. **Ethical Responsibilities**
   Ethical responsibilities are responsibilities that a company puts on itself to be environmentally friendly, paying fair wages or refusing to do business with oppressive countries etc.
4. ***Philanthropic Responsibilities***
   Philanthropic responsibilities are responsibilities that go above and beyond what is simply required or what the company believes is right. They involve making an effort to benefit society -- for example, by donating services to community organizations, engaging in projects to aid the environment or donating money to charitable causes.

Dimensions of social responsibility

Primary responsibility of an enterprise is profit generation. However, there are multiple dimensions affecting a company's activities. They are:

1. **Environmental:** This is the impact of the enterprise on the environment through adoption of practices like use of recycled materials in packaging or renewable energy sources like solar power to factory.
2. **Social:** Should aim to use business to benefit society as a whole. This could involve sourcing fair trade products, paying reasonable wages to employees and taking up endeavours that benefit society, for instance using your resources to organize charitable fundraisers.
3. **Economic:** Balance between financial impact of the social responsibilities and the profit generation so as to be a good corporate citizen.
4. **Stakeholders:** Stake holders are those affected by the actions of the enterprise – employees, suppliers and the customers. Impact of imposing more work load on employees for higher output, reducing quality standards while producing in bulk etc.
5. **Voluntariness:** A voluntary action on part of the enterprise, which is not required to be undertaken, but it is the enterprise's decision based on ethical values. Eg: use of organic products as raw material in case of a processing unit.

Social Responsibility Strategies

- ***Voluntary Hazard Elimination***

  While planning to start an enterprise, the first thinking should be on the actions to be taken to voluntarily eliminate production practices that could cause harm for the public, regardless of whether they are required by law. If an enterprise produces hazardous substances or polluting bye products or makes excessive noise and vibration should analyze the effects of it on the environment and should take necessary steps to reduce the ill effects to the local residents. A plant that uses chemicals should ensure safety measures to the staff also.

- **Social Action for Development**

  Once an enterprise starts running on an appreciable profit, it may set up a foundation for a better environment around to work by way of expressing its social responsibility. This can be by assisting in improving education facilities, ensuring better local infrastructure facilities etc., which will be viewed as assets to local community, thereby enabling the enterprise in developing a positive public profile.

- ***Philanthropy***

  Once the enterprise becomes a large business, it can think of supporting local charitable, educational and health-related organizations to assist under-served or impoverished communities, which can reduce poverty, provide education and help the environment.

- ***Social Education and Awareness***

  Educating the public on potentially harmful activities around how to protect the society from various health hazards can improve the public profile of the business firm. Community awareness and collective activism on issues of concern to the public will help in projecting the ethical business standards of the company or firm. For example, awareness programmes

on protection of water bodies from pollution, protection of mangroves in coastal zone etc. through media and social investments like development of internet facilities for improving social education related to the societal improvement can reflect the socially responsible behaviour of the enterprise.

Pros and Cons of Corporate Social Responsibility

According to Asia-Pacific Economics Blog, Corporate social responsibilities help provide for a number of different programs that help transform the world for the better, at the same time there are definitely some downsides and drawbacks to be aware of. These include:

- A proper corporate social responsibility plan can provide businesses and enterprises with a tremendous amount of value and extra profitability that they had in the past.
- By taking advantage of new technology that focusing on reduced energy dependence and improved recycling, the overall cost structure can be improved.
- Social responsibility of the enterprise can contribute to better customer relations, resulting in better repute for the company.
- Consumers today are very serious about doing business with companies that are as focused on improving their environment as they are, and green initiatives are giving companies significant "brownie points" that they wouldn't have enjoyed before.
- Enterprises taking up bigger social responsibility projects than they can afford will lead to pressure in budget and also shareholder resistance.
- Consumers are nowadays becoming very aware and sceptical about the very real intention of such projects and may treat as mere eye wash to grab positive attention, which in turn can lead to disastrous impact on the trust and rapport.

Impact of Social Responsibility in Enterprises

1. **Customer Retention**

   Customers always choose companies having reputation for being socially responsible by way of commitment to the community and the environment and also the perceived value of its products and services.

2. **Access to Funding**

   Investors look at the ethical and social standards exhibited by a business when deciding whether to commit capital to the company. Some investors focus exclusively on companies that have a demonstrable track record of social responsibility.

3. **Employee Recruitment**

   Most of the younger and talented members of the workforce have heightened awareness of environmental protection, and a company's commitment to the environment and to society and hence, social responsibility plays an important role in obtaining top talents.

4. **Positive Image**
   Companies that have ethical lapses such as ignoring environmental regulations or standards for how employees should be treated can suffer damage to their reputation when these lapses come to light in traditional or social media.
5. **Stable Cash Flow**
   Ethical, socially responsible companies can avoid the cost of litigation and other problems arising out of fines and penalties assessed by the government for lack of regulatory compliance and lawsuits from customers due to product defects or from employees due to unsafe working conditions, which can aid in maintaining a stable cash flow.

Social Responsibility and Sustainability of Enterprises

Under this context, sustainability means working with companies to help them develop plans that combine long-term profitability with maximum social responsibility and environmental care. Following some basic principles of sustainability can help your business forge a path toward larger corporate social responsibility goals (FrontStream, 2013). The three pillars of sustainability include:

1. PEOPLE: The Social Pillar of Sustainability

Different companies do this in different ways, with some of the most successful corporate sustainability programs taking an approach that ties in well with their corporate missions. For example, Nestle has committed to addressing the community impacts arising as a result of their operations including water scarcity, health and wellness of communities around their factories, and land management that honours usage rights of local people. At Walmart**,** social initiatives include market-specific skills training programs, sustainable agriculture and food donations, worker safety initiatives, and women empowerment initiatives.

2. PLANET: The Environmental Pillar of Sustainability

Environmental sustainability occurs when processes, systems and activities reduce the environmental impact of an organizations facilities, products and operations. Examples of environmental initiatives set by Walmart company include increasing imports from green and yellow factories, a goal of zero waste, plastic bag reduction, and initiatives to reduce carbon footprint by managing energy consumption.

3. PROFIT: The Economic Pillar of Sustainability

Economic sustainability involves making sure the business makes a profit, but also that business operations don't create social or environmental issues that would harm the long-term success of the company. The nice thing about taking a total approach to sustainability is that if you focus on social and environmental issues, profitability will often follow. Social initiatives have an impact

on consumer behavior and employee performance, while environmental initiatives such as energy efficiency and pollution mitigation can have a direct impact on reducing waste.

Conclusion

Social responsibility is becoming a leading principle of entrepreneurs and considered as an integral part of entrepreneurship development in maintaining good customer relations, social repute and safe working conditions of the employees. It is a necessity in business as the benefits outweigh the cost and not least for the sake of its own economic interest. Integrating sustainability and corporate social responsibility by using the three pillars – people, planet and profit can lead to a successful enterprise.

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Entrepreneurial Opportunities in Nutraceuticals developed from fish and fish wastes

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Introduction

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

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

Classification of Nutraceuticals

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

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

Dietary Supplements

According to the Dietary Supplement Health and Education Act (DSHEA), 1994 in USA, dietary supplements are defined as products comprised of "dietary constituents" and orally

administered to supplement the nutritional requirement of diet. The "Dietary constituents" refers to bioactive components comprising of amino acids, vitamins, minerals, fibres, important metabolites, and certain enzymes. The dietary supplements also include extracts available in tablets, capsules, powders, liquids, and in any other dosage form (Radhika *et al*., 2011).

Functional Food

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

Medicinal food

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

Nutraceuticals from marine sources

Chitin and chitosan

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

extensive application in multidimensional sectors, such as in food and nutrition, biotechnology, material science, drugs and pharmaceuticals, agriculture and environmental protection, dental and surgical appliances,removal of toxic heavy metals, wine clarification, industrial effluent treatment, etc. (Se-Kwon, 2010).

Glucosamine Hydrochloride

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

Chondroitin sulphate

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

Hyaluronic acid (HA)

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

Collagen, gelatin and collagen peptides

Fish skin and scales which constitutes about 30% and 5% of the total seafood processing discards respectively are considered as the richest source for collagen and gelatin. Collagen derived from marine sources is finding wide applications in various sectors due to its biocompatibility, biodegradability, high cell adhesion properties and weak antigenicity (Yamada *et al*., 2014). Another major application of collagen is to act as a source for extraction of collagen

hydrolysates, peptides, gelatin and gelatin peptides. Collagen peptides are reported to have bioactive properties like antioxidant, antimicrobial, antihypertensive, metal chelating, tyrosinase inhibitory, immunomodulatory, neuroprotective, antifreeze, wound healing, cell-proliferation, activities (Zhuang *et al*., 2009; Chi *et al*., 2014).

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

Fish lipids

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

Squalene

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

Minerals

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

Nutraceutical industry in India: Current scenario and future trends

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

Innovative work done at Central Institute of Fisheries Technology, Cochin

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

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Utilization of shellfish processing discards

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The commercial aquaculture for crustaceans in India has become a huge success due to the introduction of new species, the improved hatchery production of seeds, scientific management of culture practices and the availability of good quality feed and other input. Introduction of new species like Letopenaeus vennamei has resulted in increased yield and productivity. The farming of this species has already been established in coastal Andhra Pradesh, Karnataka and Tamil Nadu and gaining momentum in Kerala and other states.

Similarly, farmers in both coastal and land locked States have gone for large scale farming of Giant Freshwater Prawn (Macrobrachium rosenbergii) popularly called "Scampi" which is having high demand in both domestic and international markets. In order to meet the raw material requirement of large number of processing units established for export and also to meet the domestic demand. The state of Andhra Pradesh accounts for more than 50 per cent of the cultured Scampi production and also in terms of area under culture. During the year 2013-14 the estimated production of L. vannamei was 406018 tons whereas the black tiger export of cultured prawn from the country was to the tune of 41947 tons and that of scampi, it was 1401 tons (MPEDA 2008).

Industrial processing of prawn results in huge quantities of waste in the form of head and shell. Since the exported shrimp products are mainly of peeled items, the shell waste produced is quite high. The head and shell constitute nearly 60% by weight of the whole prawn depending on the species and size of the prawn. In India its availability is estimated to be 100,000 tonnes annually and it is the single largest fishery waste of the country. Crab shell and squilla are other important raw materials available from marine sector.

Proximate composition

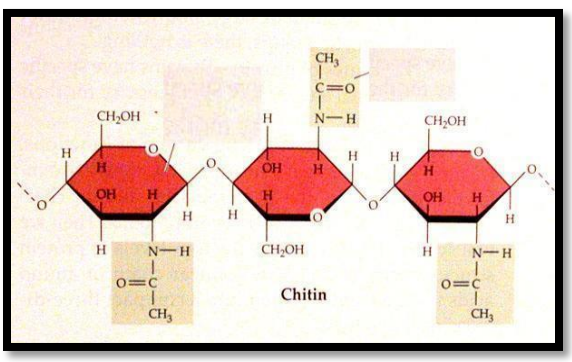
Characteristic	Prawn waste	Squilla	Crab shell
Moisture %	75-80	60-70	60-65
Ash (% dry weight basis)	30-35	33-37	45-50
Protein (% dry weight basis)	35-40	40-45	30-35
Chitin (% dry weight basis)	15-20	12-16	13-15
Fat (% dry weight basis)	3-5	2-3	1-1.5

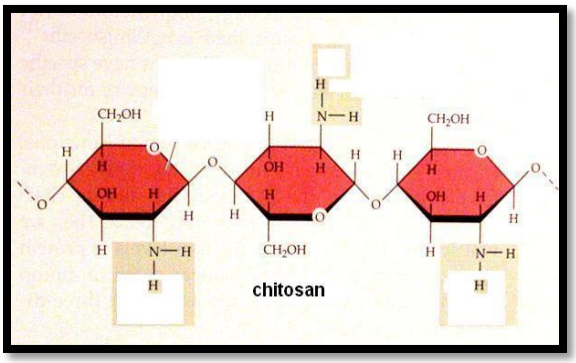
The investigations carried out at the Central Institute of Fisheries Technology, Cochin, paved the way for production of valuable food and industrial products namely protein extract, chitin

and its derivatives chitosan and glucosamine hydrochloride from the head and shell waste of prawns, crab and squilla.

Chitin (anhydro- N-acetyl- D-glucosamine (N-acetyl 2- amino 2- deoxy D-glucose) is the second most ubiquitous natural polysaccharide after cellulose on earth. It is estimated that chitin is produced annually almost as much as cellulose. Chitin is a white hard, inelastic, nitrogenous polysaccharide found in the exoskeleton as well as in the internal structure of invertebrates. The monomer units are linked by β (1-4) glycosidic bonds as in cellulose. It is insoluble in water and most organic solvents. It is the most important organic constituent of the exoskeleton of arthropods. The tough and resilient property of chitin is utilized by the living organism as skeletal support and body armor against attack by other marine animals.

The waste of these natural polymers is a major source of surface pollution in coastal areas. Chitin is considered as under utlised resource which has got high potential in new functional biomaterial in various fields. The most important economical source of this material is the shrimp processing industry. Apart from shrimp, the shells of lobster, crab, squilla and squid pens also provide chitin in large quantities. Deacetylation of chitin gives chitosan, a high molecular weight linear polymer of amino-D-glucose.





Production process for chitin and chitosan

Chitin is present in the shells of shrimp or crab or squilla as chitin protein complex along with minerals mainly calcium carbonate. The process for chitin production comprises demineralisation and deproteinisation to isolate chitin. In commercial production demineralisation is done by dilute hydrochloric acid and deproteinisation by dilute aqueous sodium hydroxide. The chitin thus isolated is deacetylated using con.aqueous caustic soda for production of chitosan.

Raw materials

The wet fresh head and body peelings of prawn collected from the peeling centers, crab shell from the processing plants and squilla caught along with prawns can be used either directly immediately on arrival at the plant or can be dried and stored and can be used when required as per

the production programme. Shell can be collected from distant centers in the dry form in which case transportation is comparatively easy and economical. Care should be taken to see that the shell should not contain sand and extraneous matter to any significant level.

Selection of raw material

If production of shrimp protein extract is envisaged during the production of chitosan more care has to be taken in the selection of raw material. Only fresh prawn waste can be used for the extraction of protein. It should be iced and hygienically stored and transported. Commercial dry shell gives only very dark coloured protein paste. Moreover, cleaning of the shell is not practical as it normally contains objectionable foreign matters. But, if chitin/chitosan alone is the desired end product dry commercial shell can be used as the starting material.

Production process

The process involves two important stages. (1) Isolation of chitin from shell (2) Conversion of chitin to chitosan.

Isolation of chitin

Chitin is isolated from the shell by demineralisation followed by deproteinisation. If extraction of protein is envisaged for production of shrimp extract only hygienically collected fresh prawn shell has to be taken for processing. The fresh shell has to be treated first with 0.5% dilute aqueous caustic soda and the alkaline protein solution is drained out and kept separately for neutralization, concentration and drying. The residual shell is then deproteinised followed by demineralisation.

Demineralisation

Demineralisation is the process by which the minerals are removed from the shell. If recovery of the protein is not envisaged the wet or dried shells can be directly treated with dilute commercial hydrochloric acid at concentration around 1.25 N at room temperature. The demineraliser is an open cylindrical tank of size 2 m x 1.5 m made of S.S. or M.S. or brick masonry lined inside and outside with fiber glass having perforated false bottom made of S.S wire mesh with 3 mm mesh size and with sufficient reinforcement at the lower end of the cylindrical portion. The vessel is fitted with a propeller agitator of 60 rpm and 80 cm sweep driven by a 5 HP electric motor from the top for gentle agitation of the mass to facilitate the reaction and to avoid floating of the shell. The vessel is so installed that the acidic effluent can be drained by gravity to the fiber glass lined collection tank constructed in brick masonry by the side of the demineraliser. The demineraliser is to be housed in a well-ventilated place with suitable exhaust facility to remove the acid fumes as well as the carbon dioxide coming out during demineralisation of the shell.

Demineralisation is an important step in the production of chitin and chitosan. The degree of demineralisation determines to a great extent the characteristics of chitosan.

Deproteinisation

The deproteinisation is the process by which the protein is removed from the chitin protein complex. The shell after demineralisation and washing free of acid is shifted to the deproteiniser where it is treated with 5% aqueous caustic soda at 70-80^{0}C with continuous stirring at an rpm of around 100 using propeller type stirrer for about 30 minutes in a false bottomed steam jacketed open cylindrical M.S. vessel having arrangements for heating either by steam or by thermic fluid heat exchanger. By 30 minutes the protein from the shell will dissolve in the alkali which can be drained off. The residue is washed well with water to make it free from alkali. This requires at least three washings in potable water with agitation. The product is wet chitin.

Deacetylation of chitin to chitosan

The wet chitin from the deproteiniser is transferred to the cemented collection tank and there to the centrifuge/hydraulic press/screw press for removal of water to the extent possible. The dewatered chitin cake is charged to the deacetylator where it is treated with 50% (w/w) aqueous caustic soda solution at 90-95^{0}C for 1.5 to 2 hours or longer till the deacetylation reaches the required level. After deacetylation, which is ascertained by checking the solubility in 1% acetic acid, the alkali is recovered for reuse. The residue washed twice with minimum quantity of water and collected for reuse making up the concentration. The alkaline chitosan mass is washed well either in the same vessel or after transferring to a storage tank and taking in small quantities to a S.S. washing vessel to remove residual alkali.

Dehydration

The alkali free chitin or chitosan from the washing vessel is collected in canvas bags and pressed under a screw press or hydraulic press or centrifuged to remove the adhering water as far as possible. The residue is wet chitin/chitosan with moisture content around 70%.

The wet alkali free chitin/chitosan cake is taken out, fluffed and spread in clean aluminium trays and dried in hot air drier at temperature 65-70^0 C. Alternatively it can also be sun dried by spreading in open cemented floor protected from dust and other contaminants to moisture content below 7%.

Pulverization

The dried chitin/chitosan is sorted manually to remove any foreign material before pulverizing. The pulverizing can be done in a swinging hammer type or a pin type pulveriser fitted with a balloon or cyclone collector to the desired particle size by suitably changing the screen. Sorting is an important step for getting high quality chitin. The foreign matter like match stick,

feather, nylon pieces etc. which are normally present in the shell will be carried to the product even after demineralisation and deproteinisation. No mechanical separation is as effective as manual separation although it involves considerable labour.

Bagging and storage

The powdered chitin/chitosan can be bagged in polythene lined HDPE (high density polythene) woven sacks. Usually a bag of size 100 cm x 65 cm is used for this purpose which can hold 25 kg chitin of 1 mm size or 40 kg chitosan of 0.25 mm size produced from prawn waste or 30 kg chitin or 50 kg chitosan from crab shell. Such bags can withstand all transporting hazards.

Product quality

In commerce chitin and chitosan with the following characteristics are acceptable to the end users.

Characteristics	CHITIN	CHITOSAN
Moisture %	<10	<7
Ash %	<2	<1
Protein %	<2	nil
Colour	off white	off white
Particle size	10-20 mesh	60-80 mesh
Solubility in 1% acetic acid	nil	soluble
Insolubles in 1% acetic acid	N.A	<0.5
pH	7.0-7.5	8-9
Nitrogen %	6.5-6.8	7-7.5
Deacetylation %	N.A	>80
Viscosity (m pa s) in 1% acetic acid at 1% level at 28°C	N.A	<100

The process described above will give chitosan of medium viscosity from commercial dry prawn shell. For low, high and special grade chitosan for specified end use parameters like time, temperature, concentration of acid and alkali during demineralisation and deproteinisation and deacetylation are to be suitably modified in addition to raw material selection. Strict quality control measures are to be adopted for minimising batch to batch variation.

Glucosamine:

Hydrolysis of chitin with concentrated hydrochloric acid causes deacetylation and breakdown of the polymer releasing the monomer as glucosamine hydrochloride. Dry Chitin powder was hydrolyzed with concentrated Hydrochloric acid in a glass lined reactor equipped with

reflux condenser in a thermostatically controlled digital water bath with occasional stirring. The temperature of the reaction mixture was slowly raised to the optimum level and maintained at that level for the completion of reaction until the solution no longer gives opalescence in dilution with water. During the process the liberated HCl gas was absorbed in water. The excess acid can be distilled off under vacuum after completion. The undissolved residue, was filtered after adding equal quantity of water. To this mixture 10% activated charcoal was added and the solution was warmed to 60o C for 30 minutes and filtered. If the filtrate still coloured repeat the treatment with little quantity of charcoal. This pale yellow solution was evaporated to dryness in a reduced pressure and mixture was washed with alcohol and dried under vacuum. Glucosamine hydrochloride is an approved nutraceutical product. It is prescribed as a remedy for osteo arthritis and approved by USFDA. It is found to have antiflamatory and antiulcerogenic properties.

Chitooligosaccharides (COS) applications:

Production of COS is of immense interest since these oligosaccharides are thought to have several interesting bioactivities. COS produced using endochitinase showed antibacterial activity against bacteria, that cause diarrhoeal and emetic syndromes in humans. Potential effects of COS reported were: as drugs against asthma, antibacterial agents, anti-fungal agents, ingredients in wound-dressings, reduce metastasis of tumors, increase bone-strength in osteoporosis, inhibit chitinases in *Plasmodium* parasites and thereby prevent malaria, immune modulators, and a lowering effect on serum glucose levels in diabetics.

Applications of Chitin, Chitosan and Glucosamine

Chitin and its derivatives, particularly chitosan (deacetylated chitin) find industrial application in various fields namely flocculation, paper making, textile printing and sizing, ion exchange chromatography, removal of metal ions from industrial effluents, manufacture of pharmaceuticals and cosmetics and as an additive in food industry. Several versatile applications of chitosan have been developed during the last three decades. There are about 200 current and potential applications of chitin and its derivatives in industry, biotechnology, food processing, pharmacy and medicine.

The application of chitosan for improvement of quality and shelf life of food products have been well documented. It can be directly incorporated into the food or can be used as coatings for food products or can be made as an integral part of the packaging materials. All these techniques are found to have beneficial effects on the food during processing and storage. Edible coatings can be used as a vehicle for incorporating functional ingredients such anit-oxidants, flavours and colors antimicrobial agents and nutraceutical into the food products whereby adding more value to the product. The applications of chitosan in the field of nanotechnology is being studied widely. It was observed that the antimicrobial properties of nano chitosan is far better when compared to natural

chitosan. Nanochitosan in conjunction with metal ions have also been found to have applications in different fields.

Glucosamine hydrochloride and sulphate are marketed as food supplements for the treatment of osteoarthritis. Anti-ulcerative effect of glucosamine was recently reported. In the US glucosamine is one of the most common non-vitamin, non-mineral, dietary supplement used by adults. Since glucosamine is a precursor for glycosaminoglycans and glycosaminoglycans are a major component of joint cartilage, supplemental glucosamine may help to prevent cartilage degeneration and treat arthritis. Glucosamine and N-acetyl glucosamine help in building up connective tissue in joints (e.g. gycosamionoglycons (GAG), chondroitin and hyauronic acid). Glucosamine acts not only as a substrate for the synthesis of GAGs but also stimulates their synthesis and prevents degradation. Different combinations of glucosamine are now in use for treatment of arthritis and the annual global consumption of glucosamine exceeds 6000 tons.

Shrimp shell waste can be efficiently utilized by transforming it to value added by-products like chitin, chitosan, glucosamine and chitooligosaccharides that have wide and varied industrial applications.

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Engineering tools and technologies for energy efficient fish processing operations

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

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

1. Technologies for fish processing and value addition

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

1.1 Solar dryers

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

In a hybrid solar drying system, drying can be continued during off-sunshine hours by utilizing backup heat source and stored heat energy of daytime sunshine. In this way, drying becomes continuous process and the product is saved from possible deterioration by microbial infestation. These types of Hybrid solar dryers find useful applications in developing countries where the conventional energy sources are either scarce or expensive and the heat generating capacity of the solar system alone is not sufficient. Further, to assist the drying process (forced convection) in a hybrid dryer, a small blower is attached in between solar collector and drying chamber or inside the drying chamber which is powered by solar PV panels installed on drying chamber. Moreover, power from PV panels can be used for street lighting purposes. In addition,

if the proposed setup is not used for drying purpose (kept idle), then the same can be used to draw hot water for domestic use. Therefore, in a single set up it is envisaged to have multiple utilities i.e. drying of fish, hot water and electricity generation.

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

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

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

a) **Solar Dryer with LPG back-up:** ICAR-CIFT designed and developed a novel system for drying of fish using solar energy supported by environment friendly LPG back up (Fig.1). In this dryer during sunny days fish will be dried using solar energy and when solar radiation is not sufficient during cloudy/ rainy days, LPG back up heating system will be automatically actuated to supplement the heat requirement. In the solar fish dryer with LPG back up heating system, water is heated with the help of solar vacuum tube collectors installed on the

roof of the dryer and circulated through heat exchangers provided in the PUF insulated stainless steel drying chamber loaded with fish. Thus continuous drying is possible in this system without spoilage of the highly perishable commodity to obtain a good quality dried product.

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

Fig.1. CIFT Solar-LPG Dryer

b) Solar dryer with Electrical back-up: Effective solar drying can be achieved by harnessing solar energy by specially designed solar air heating panels and proper circulation of the hot air across the SS trays loaded with fish (Fig.2). Food grade stainless steel is used for the fabrication of chamber and perforated trays which enable drying of fish in a hygienic manner. Since the drying chamber is closed, there is less chance of material spoilage by

external factors. An alternate electrical back-up heating system under controlled temperature conditions enables the drying to continue even under unfavourable weather conditions like rain, cloud, non-sunny days and in night hours, so that the bacterial spoilage due to partial drying will not occur. Improved shelf life and value addition of the product fetches higher income for the fisher folk. The eco-friendly solar drying system reduces fuel consumption and can have a significant impact on energy conservation.

Fig.2 CIFT Solar-Electric Dryer

c) Solar-Biomass Hybrid dryer: A dryer working completely on renewable energy was designed and developed for eco- friendly operation. Solar Biomass Hybrid Dryer consists of well insulated and efficient solar air-heating panels, drying chamber, SS mesh trays, photo-voltaic cells, fans and biomass heating system (Fig.3). Hot air is generated by virtue of solar

energy inside the heating panels and passed into the drying chamber. Continuous flow of hot air is maintained with the help of PhotoVoltaic cells and fans to enable drying process. During cloudy days when sufficient solar energy is not available to maintain required temperature within the dryer, an alternate biomass heating system is manually actuated. Thus a fully green technology for fish drying is achieved by this.

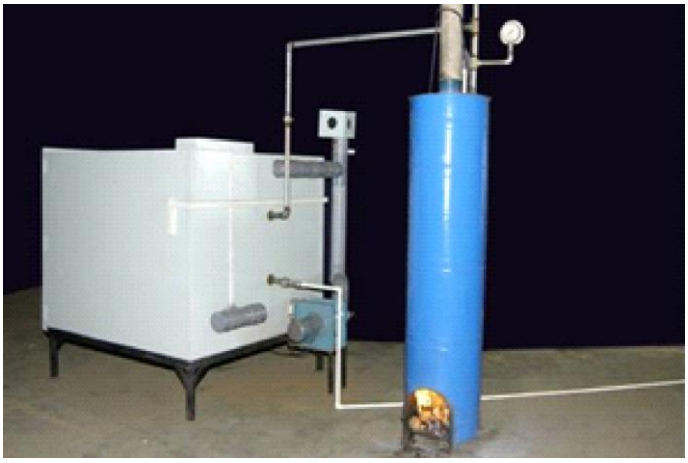

Fig.3 CIFT Solar-Biomass Dryer

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

Fig.4 CIFT Solar-Tunnel Dryer

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

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

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

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

1.2 Fish Descaling Machines

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

Fig.6 Fish descaling machine with variable drum speed

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

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

remove the scale and provided with a leak proof door with suitable lock. A pedal is fitted in the side to rotate the drum manually.

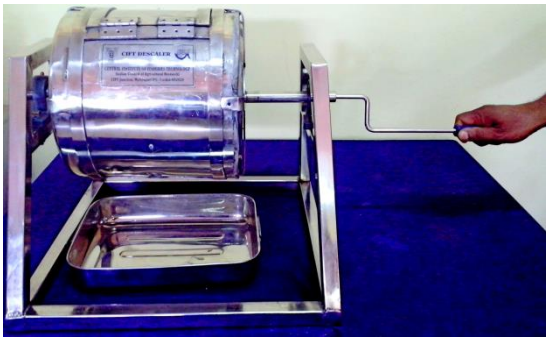

Fig.7 Fish descaling machine hand operated

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

1.4 Modern Hygienic Mobile fish vending kiosk: Most of the fisher folk across India sell fish in an open basket without any hygienic practices. The fish is kept in an open bag or container, it loses its freshness.They use ice purchased at high cost for temporary preservation and at the end of the day, if the fish is not sold, they give it at a low rate to customers with little or no profit. More over fish gets contaminated under unhygienic handling practices. The fish vending persons, especially women folk find it difficult to carry the fish as head load and subsequently sell it in the local markets or consumer doorsteps. In this context, the ICAR-CIFT have designed and developed a mobile fish vending kiosk for selling fish in the closed chilled chamber under hygienic conditions at consumer doorstep (Fig.8).

Fig.8 Refrigeration enabled Mobile Fish vending kiosk

The major advantages of the new Kiosk are as follows:

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

- It also reduces human drudgery and avoids cross contamination, consumes less time. Fish dressing deck with wash basin also designed conveniently to prepare fresh clean fish under hygienic conditions.

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

1.5 Electronics and Instrumentation:

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

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

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

2. Commercialization and Agri-Business Incubation

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

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

research inputs. The Agribusiness Incubator Program also seeks to provide business consulting services to agriculture-related businesses and helps to develop a strategic business plan.

The Engineering Division of ICAR-CIFT has commercialized its technologies like solar fish dryers, fish descaling machines, refrigeration enabled fish vending machines etc through the ABI. On non-exclusive license mode, 10 firms have been empanelled to manufacture/fabricate machineries as per CIFT design and commercialize it to needed customers by paying royalty to the institute.In the financial year 2018-19itself, 15 entrepreneurs have taken up Solar fish drying technology and three start-ups came up by establishing CIFT designed fish vending kiosks. Five fish descaling machines were also successfully handed over to sea-food industries located both in Andhra Pradesh and Kerala. Apart from these, 10 numbers of fish dryers of 10 kg capacity were distributed among women SHG groups located in Kerala, Manipur and Assam for demonstration purposes. Furthermore, 28incubatees(one physical and two virtual) have already registered under ABI in the current year for using engineering technologies. Apart from these, an MOU was signed between ICAR-CIFT and Society for Assistance to Fisherwomen (SAF), Directorate of Fisheries, Govt of Kerala, for fabrication and installation of 20 numbers of Refrigerated fish vending kiosk for the benefit of fisher women SHGs.

3. Energy and Water Use Optimization in Seafood Processing Industry

Energy consumption in seafood or any food processing plant depends largely upon the age and scale of the plant, level of automation, intensity and type of processing operations, plant management practices, plant layout and organization, equipment efficiency and range of products manufactured. The cooking and canning are very energy-intensive processes, whereas the filleting consumes less energy. Thermal energy, in the form of steam and hot water, is used for cleaning, heating, sterilizing and for rendering. The operation of machinery, refrigeration, ventilation, lighting and production of compressed air uses high amount of electricity (Fig. 9). Similarly, seafood industry consumes significant amounts of water in each stage of processing (Fig.10). It also produces a large quantity of waste water. The CIFT have installed energy meters in three industries within Kochi cluster for monitoring the daily energy consumption pattern.

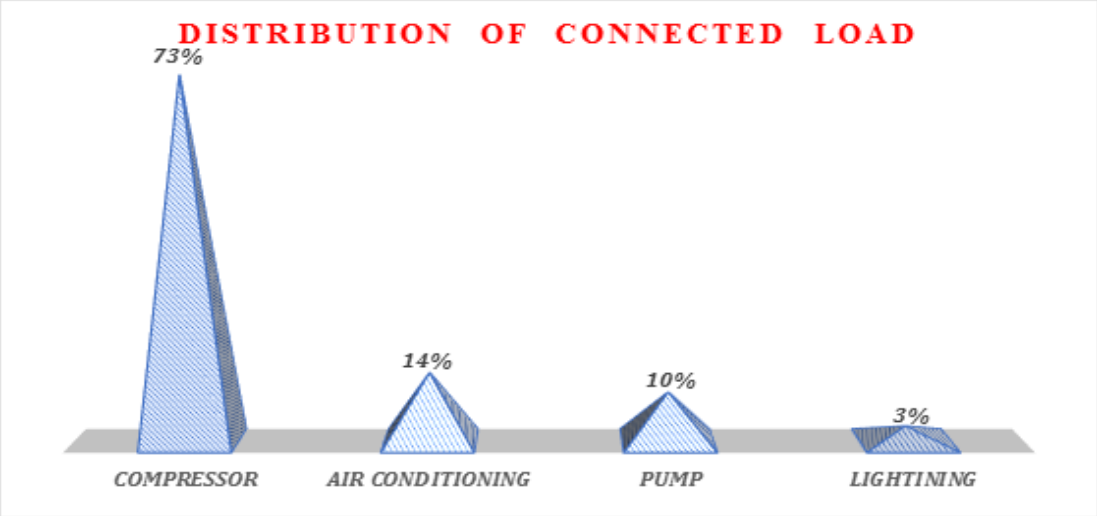

Fig. 9 Distribution of connected load in seafood processing units of the Kochi cluster (Source: BEE, 2015)

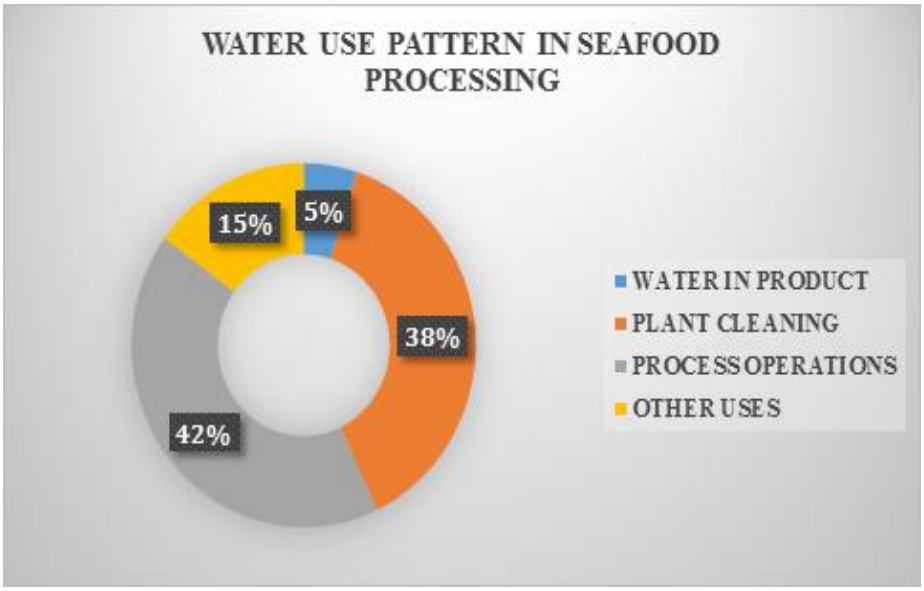

Fig. 10 Water use pattern in a typical seafood processing unit. (Source: BIM, 2017)

3.1 Energy optimization methodologies

Energy optimization methodologies can be broadly classified in the following six categories:

i ***Automation of existing process line:*** Energy wastage in the seafood industry can be greatly reduced by precisely controlling the working of all equipment in the process line. Merely by controlling the timely switching on and off equipment can save a lot of energy, which can be practically impossible in manual operation.

ii ***Sensitize the labor about energy conservation:*** The operation level labor's attitude and behavior have a major impact on the energy optimization point of view. Awareness among the labors regarding energy wastage that can occur due to mere negligence or ignorance has to be created. Instructions can be given to them regarding reducing energy wastage, for example, the chill room doors should be closed immediately after loading or unloading to prevent temperature rise inside etc.

iii ***Equipment upgrade:*** Existing equipment should be monitored for their efficient working through periodic repair and maintenance. Regular servicing and if required replacement of worn out parts should be done. This can actually improve the processing efficiency of the equipment and in turn of the whole plant. The usage of plate freezers considerably reduces the energy consumption in seafood freezing.

iv ***Replacement of out-dated equipment and technology:*** Latest technologies and sophisticated and energy saving equipment can be explored to reduce the energy consumption of plant. For example, reciprocating and centrifugal type compressors can be replaced by a screw compressor, which can give higher processing efficiency or Replacement of existing V-belt drive with synthetic energy efficient flat belt drive in the compressor motor. The direct contact water condensers can be replaced by Evapco type condensers. Installation of Variable Frequency Drive (VFD) for condenser water Pumps. These are relatively capital intensive method but high reduction in energy consumption can be obtained.

v ***Energy auditing and budgeting:*** Effective reduction in energy consumption can be achieved through proper energy auditing of the seafood industry. Energy audits can give an idea about the extent of energy utilized for various purposes in the industry and accordingly energy conservation measures can be executed. The energy auditing can be made easy through software like Energy Datamatrix which periodically check the energy consumption in seafood processing sectors.

vi ***Use of renewable energy and green industry concept:*** Switching to renewable energy sources from conventional sources are of great advantage not only to the industry but also to the environment as a whole. Nowadays, the green industry is a trending concept which emphasizes on those activities and measures which help curb environmental depletion, swapping to renewable energy.

3.2 Water Optimization Methodologies

Substantial reduction in water consumption of a seafood processing industry can be brought about by adopting some of the below-mentioned methods.

i ***Automation of equipment and process-line:***The extent of reduction in water consumption possible by automating the equipment cannot be overlooked. Conventional taps may be replaced by self-closing ones. Cut-off valves, flow diversion valves etc. are dependable accessories which may be installed in the process-line to reduce water wastage. Sensor based solenoid valves may be fitted to the water supply system which can be operated automatically or by means of an Internet of Things (IoT) system.

ii ***Monitoring water use pattern:*** Close monitoring of the industry's water use pattern can give a lot of insights. Sensors may be installed in relevant points in the process-line for the same. This can be especially helpful in detecting any leaks by observing the sensor readings during the night. Even though this can incur some initial expenses to the industry, the savings both in terms of money and resources are exceptionally high. Many researchers have successfully developed system for online water monitoring based on different algorithms and tools like genetic Algorithm, Artificial neural networks, ZigBee, GPRS etc.(Liu et al, 2013; Yu et al., 2016).

iii ***Recirculation and recycling:*** Considering the safety standards a seafood industry should maintain and there are some constraints in adopting recycling of water in the process line. Nevertheless, opportunities for possible recirculation of water may be explored to reduce water consumption. Recirculated water can be used for employee wash rooms, Effluent Treatment Plant (ETP) operations and direct groundwater recharging. According to the literature, it is anticipated that a recycling unit in thawing equipment can reduce water consumption by 60 %.The different methods used for the treatment of wastewater in seafood

industries are dissolved air floatation, dual media filter, activated carbon filter, sand filtration and tank stabilization, flash mixer, clariflocculator, secondary clarifiers and sludge drying beds, etc. Coarse material and settleable solids are removed during primary treatments by screening, grit removal and sedimentation.

iv ***Updating or modifying conventional systems:*** Minor changes may be incorporated into the existing system to utilize the available resources smartly. For example, trigger action shut off devices or nozzles can be fitted onto the hose, the addition of timers or pedals to ensure water, adjusting the flow to the minimum required to maintain performance etc. This can be relative very cheap in investment but can tremendously improve the cleaning potential of water since it is pressurized during application. Almost 40% reduction in water usage can be attained by this method.

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Enhancing Farm Income through Entrepreneurship Development in Fisheries Post harvest sector

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Introduction

Value addition means "any additional activity that in one way or another changes the nature of a product, adding to its value at the time of sale". It is the most talked about word in food processing industry, particularly in export oriented fish processing industry, because of the increased realisation of valuable foreign exchange. Of the fish destined for direct human consumption, the most important product form is live, fresh or chilled fish, with a share of 46.9 % in 2010, followed by frozen fish (29.3 %), prepared or preserved fish (14.0 %) and cured fish (9.8 %) (Anon.2012).Value can be added to fish and fishery products according to the requirements of different markets. These products range from live fish and shellfish to ready to serve convenience products. There is a great demand for seafood/seafood based products in ready to eat "convenience" forms. A number of such diverse products have already been available in the western markets. One of the factors responsible for such a situation is more and more women getting educated and taking up employment and not having much time for traditional cooking. Reasonably good expendable income, education, awareness and consciousness towards hygiene and health, increased emphasis on leisure pursuits, etc. are some of the other reasons.

Marketing of value added products is completely different from the traditional seafood trade. It is dynamic, sensitive, complex and very expensive. Market surveys, packaging and advertising are a few of the very important areas, which ultimately determine the successful marketing of a new product. Most of the market channels currently used are not suitable to trade value added products. A new appropriate channel would be the super market chains which procure directly from the source of supply of the products and control most of the components of production and supply chain like packaging, advertising and retail marketing. Appearance, packaging and display are all important factors leading to successful marketing of any new value added product. The retail pack must be clean, crisp and clear and make the contents appear attractive to the consumer. The consumer must be given confidence to experiment with a new product launched in the market. Packaging requirements change with product form, target group, market area, species used and so on. The packaging technology needs to be evolved which should be attractive, convenient and adding to the shelf life of the processed products (Gopal et al, 2015).

The Agri-Business Incubation (ABI) Centre and Zonal Technology Management Centre (ZTMC) established at ICAR-CIFT, Cochin supports operations on business projects as a measure of

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

Major Technologies in fisheries post-harvest sector are outlined below:

Processing Methods

The methods used for freshwater fish includes chilling, modified atmosphere packaging, active packaging, freezing, drying, thermal processing, drying and smoking. Major freshwater fish species which can be used for the production of coated products are Rainbow trout (*Oncorhynchus mykiss*), European eel (*Anguilla anguilla)*, Japanese eel (*Anguilla Japonica*), Milk fish (*Chanos chanos*), Channel catfish (*Ictalurus punctatus*), Nile tilapia (*Oreochromis niloticus*), Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus mrigala*), Common carp (*Cyprinus carpio*), Roach (*Rutilus rutilus*), etc. Prominent fresh water shellfish are scampi (*Macrobrachium rosenbergii*) and crayfish.

Live fish: Many fishes if sold in live condition fetch a much higher price than in the frozen or chilled forms especially in overseas markets. Hence, it is becoming a general practice to transport those varieties of fish and shellfish to the prospective markets in the live condition. They are also sold in the live condition in the super markets. Murrels are being transported in live condition in India to distant overseas markets. Fishes like channa,catfish etc. are preferred in live condition. In North Eastern States, carps are also fetching better price in live condition. Although fish are transported in live condition, it is essential to evolve much better technology to transport them to distant places and with full freshness to fetch better price.

Chilled fish: Chilled fish is another important value added item of international trade. Immediate chilling of fish ensures high quality products (Connel, 1995: Huss, 1995).Chilled fish fetches more price than frozen fish. . Indian major carps like, catla, mrigal and rohu packed in boxes in iced condition and exported. From Andhra Pradesh different species of fish is packed in boxes,

transported to Calcutta and other major cities in trucks or by rail in chilled condition. Chilled storage life of fish depends on several factors such as composition, microbial contamination and the type of microflora present in the fish (Venugopal, 2006). Up to 35% yield of high value products can be expected from fish processed within 5 days of storage in ice, after which a progressive decrease in the utility was observed with increase in storage days and beyond 9 days of ice storage no high value products could be processed (Venugopal and Shahidi, 1998).

***Vacuum packaging*:** In vacuum packaging, air inside the pack is removed completely and sealed immediately. This helps in reducing the oxidation in fatty foods and also reduces the growth of aerobic microorganisms thereby extending the shelf life considerably.

Modified atmospheric packaging (MAP): Modified atmospheric packaging is a process by which the shelf life of fish is increased by enclosing it in an atmosphere so modified that it slows down the degradation by microorganisms and development of oxidative rancidity. In practice fish/fish products are packed in an atmosphere of carbon dioxide and other gases like oxygen and nitrogen. MAP chilled fish has an extended shelf life of 10 days or more depending on the species. Different combinations of gases have been studied for extension of shelf life of fish in a modified atmosphere. Elevated carbon dioxide levels in MAP have been shown to inhibit the normal spoilage flora of seafood and double or triple the shelf life. Studies conducted at CIFT proved that a mixture of 80% carbon dioxide and 20% oxygen was more effective in extending the shelf life of *Catlacatla* fillets when stored at 0-4^{0}C. The shelf life was limited to 28 days using 80% carbon dioxide and 20% oxygen, 20 days in a mixture of 50% carbon dioxide and 50% oxygen compared to 12 days in air. Dressed and gutted pearl spot packed in 60% carbon dioxide and 40% oxygen had a shelf life of 11 days in air compared to 22 days in modified atmosphere packaging. Rohu fish fillets packed in 40% carbon dioxide, 30% oxygen and 30% nitrogen had a shelf life of 28 days in MAP compared to 18 days in air (Gopal,2009). MAP can be effective if used in conjunction with packaging materials of correct O_2/CO_2 permeability characteristics. Properties required may not be found in one polymer, hence laminated films or multilayer films are used.

Active packaging: Active packaging is 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' (Vermeiren et al. 1999). These systems can be classified into active scavenging systems (absorbers) and active releasing systems (emitters). Scavenging systems remove undesirable compounds such as oxygen, excessive water, ethylene, carbon dioxide, taints and other specific food compounds. Releasing systems actively add compounds to the packaged food such as carbon dioxide, water, antioxidants or preservatives. Most important active packaging components includes: O_2 and ethylene scavenging, CO_2 scavengers and emitters, moisture

regulators, anti-microbial packaging, antioxidant release, release or adsorption of flavours and odours.

Oxygen scavengers is mainly used to prevent oxidative reactions, discolouration and mould growth. Different Oxygen scavengers are chosen depend on the amount of Oxygen to scavenge (pack size and material) and product water activity. Oxygen scavengers for high water activity foods react faster compared to scavengers for dry foods but in general the absorption is slow and exothermic. Work carried out at CIFT using O_2 scavenger, an extension of shelf life for about 10 days was achieved for catfish (*Pangasius sutchi*) steaks packed in EVOH pouches in chilled conditions.

In some cases, like meat and fish products, high CO_2 levels (10-80%) are desirable to extend the shelf-life. CO_2 has a inhibitory effect on bacterial growth. It is particularly effective against gram-negative, aerobic and psychrotrophic spoilage bacteria, such as pseudomonas sp. The commercial CO_2 emitters are based on either ferrous carbonate or a mixture of ascorbic acid and sodium bicarbonate. Studies conducted using salmon fillets with soluble gas stabilization technique with combined oxygen absorber and carbon dioxide emitter (Ageless G-100) indicate fast microbial growth stored in air without absorbers and slower growth rate using absorbers and emitter.

***Frozen fish fillets*:** Many varieties of fresh water fishes like rainbow trout, shell fishes, catla, rohu, tilapia fillets can be frozen for domestic market and export to developed countries in block frozen and IQF forms. In the importing countries these fillets are mainly used for conversion into coated products. Fish fillets can also be used for the production of ready to serve value added products such as fish in sauce and fish salads.

Individually quick frozen products: IQF products fetch better price than conventional block frozen products. However, for the production of IQF products raw materials of very high quality needs to be used, as also the processing has to be carried out under strict hygienic conditions. The products have to be packed in attractive moisture-proof containers and stored at -30°C or below without fluctuation in storage temperature. Thermoform moulded trays have become accepted containers for IQF products in western countries. Utmost care is needed during the transportation of IQF products, as rise in temperature may cause surface melting of the individual pieces causing them to stick together forming lumps. Desiccation leading to weight loss and surface dehydration are other serious problems met with during storage of IQF products.*Some of the IQF products in demand are the following:* Prawn – Whole, peeled and deveined, cooked, headless shell-on, butterfly fan tail round. Fish fillets – Fillets of rohu, tilapia, catla, trout & catfish.

Battered and breaded products: Coated products viz., fish fingers, squid rings, cuttlefish balls, fish balls and prawn burgers form one of the major fish and shellfish based items of trade by the ASEAN countries (Chang et al., 1996).Battered and breaded seafood offers a convenience food valued widely by the consumer. Battered and breaded items are included in the value added products because the process of coating with batter and bread crumbs increases the bulk of the product thereby reducing the cost element. The pick-up of coating on any product can be increased either by adjusting the viscosity of batter or by repeating the process of battering and breading. As a convention 50% fish portion is expected in any coated product.

Ready to serve fish products in retortable pouch: Ready to serve fish products viz. curry products, in retortable pouches are a recent innovation in ready to serve fish products for local market. The most common retortable pouch consists of a 3 ply laminated material. Generally it is polyester/aluminium/cast polypropylene. Some of the products are rohu curry, prawn curry, mahaseer fish curry, prawn kurma and prawn Manchurian. These products have a shelf life of more than one year at room temperature. As there is increasing demand in the national and international markets for ready to serve products the retort pouch technology will have a good future. The technology for retort pouch processing of several varieties of ready to serve fish and fish products has been standardised at CIFT and this technology has been transferred successfully to few entrepreneurs in the country. The demand for these products is very good. Work carried out in Central Institute of Fisheries Technology has shown that different commercially important species viz., oil sardine, mackerel, seer fish prepared in curry medium and packed in retort pouches having composition polyester / aluminium foil / cast polypropylene remained in excellent condition for a period ranging from 18 to 36 months at ambient storage conditions (Ansar Ali et al., 2005; Ravishankar et al. 2002; Gopal et al., 2001).

Ready to eat combination meal in polypropylene trays: Ready to eat combination meal consisting of rohu fish curry and parboiled rice were developed using indigenous thermoformed polypropylene trays. In this, rohu and parboiled rice/tapioca were packed in separate trays and thermal processed to an F0 value of 8.0 min at 121^0C. The developed product had a shelf life of 15 months at ambient temperature.

Ready-to-eat fish-kure: CIFT has worked on the production of extruded products by incorporating fish mince with cereal flours. One such popular combination is the combination of Japanese threadfin bream (*Nemipterus japonicus*) mince with rice flour and Bengal gram flour. The product obtained is finally coated with Chaat masala to provide a mouth-watering snack that has been christened as "Fish Kure".Similarly extruded fish products can be prepared from fresh water fish fillets frames and other low value fresh water fishes.

Fish Soup Powder: Soup powder prepared from different materials like vegetables, meat, egg, chicken etc. are very popular and widely consumed in different parts of the world. These are rich in constituents like protein, vitamins, fat and minerals. However, soup processed out of fish is not so common. Fish soup powder contains partially hydrolysed protein, carbohydrates, fat and several seasoning compounds including salt and is hygroscopic in nature. Fishes of low economic value can be used to prepare this product which will have good export as well as domestic markets.

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

Zonal Technology Management Centres of ICAR

The IP and technology management drive of ICAR has entrusted the Zonal Technology Management Centres (ZTMC) to establish a mechanism that accedes to the conditions of international standards and also to find ways for stimulating research, enabling access to technology and promoting enterprise growth, all for the ultimate benefit of the Indian farming community.

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

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

a globally competitive one. The Unit has the powers and flexibility to outsource for efficient execution of IP and commercialization matters.

The ZTMC established at ICAR - CIFT is one of the hubs for R&D information management in ICAR for South India. The Centre caters to the needs of following ICAR research institutions that are specialized in Fisheries sector.

- Central Institute of Fisheries Technology (CIFT), Cochin
- Central Institute of Brackishwater Aquaculture (CIBA), Chennai
- Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar
- Central Marine Fisheries Research Institute (CMFRI), Cochin
- Central Inland Fisheries Research Institute (CIFRI), Barrackpore
- Central Institute of Fisheries Education (CIFE), Mumbai
- National Bureau of Fish Genetic Resources (NBFGR), Lucknow
- Directorate on Coldwater Fisheries Research (DCFR), Bhimtal

Business Incubation Centre at CIFT

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

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

Process of Business Incubation

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

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

Client Selection

The process of client selection starts with the review of applications submitted by the Entrepreneur for becoming Business Incubator Client. The application must address the requirements described a prescribed format which includes executive summary, vision and focus, financial plan and economic impact of the proposed business. The application and the proposal will be first reviewed by the Principal Investigator of the Business Incubation Centre against the set criteria. During the second stage of the selection process, applications will be evaluated by a Joint Evaluation Committee. The committee reserves the right to request additional information

from an applicant, or reject / accept an application. During the committee's review, applicants will be required to make presentations of their proposals. Once selection procedures are completed, the Client can sign Memorandum of Understanding with CIFT, for availing the facilities and services of ABIfor a limited period of time on a payment basis.

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

Services and facilities offered

The Incubation Centre provides shared physical workspace, management and technical assistance, access to financing and other supporting services to the incubating entrepreneurial firms. Incubation facilities under one roof are:

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

Pilot Level Production Lines

A state-of-the-art generic semi-commercial production facility is made available to incubating entrepreneurs for developing value added products from fish. ABIprovides access to these facilities along with support of manpower, and assists the entrepreneurs in production and testing of new product formulations. For the tenants, the pilot plant is an ideal testing arena to determine the commercial viability of new products. The plant also serves as a process lab, a place to see how processing equipment impacts food products under varying conditions.

Various lines available with ABIfor entrepreneurs are listed below:

- Fish Pre-Processing line
- Retort Pouch Processing unit
- Fish Canning line
- Fish Sausage production line
- Fish extruded product line
- Fish Curing and Drying line
- Fish battering and breading line

- Fish product packing system line
- Chitin & Chitosan Production line

By providing access to these resources, the Centre greatly reduces one of the major barriers to the commercialization of institute technologies by smaller firms - the high capital cost of intermediate or large scale process equipment.

Business Services

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

Facilitation for financial assistance

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

Promotion of ICAR Technologies

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

Human Resource Development

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

Outcomes

- Transmitting benefits of developed technologies to the nation fast and effectively
- Distributed regional economic growth and national wealth creation through SMEs
- Creation of gender equity and economic independence to women through SHG clustering
- Reduced chances of failure for first generation entrepreneurs and consequent saving of national wealth
- Import reduction and enhanced national life style through introduction of innovative products and services
- Increased national savings through efficiency enhancement of industries
- Employment generation
- Enhanced build-up of human resources and national IPRs
- Encourage thrust towards solution driven research to benefit target groups
- Increased revenue to host Institute

Lessons Learned in Business Incubation and Way Forward

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

Conclusion

Amidst the changing paradigms and demanding global structure, India, in order to remain a frontrunner among developing nations, has primarily focused on the agriculture sector. The scope and level of protection of intellectual property rights (IPRs) has been increasing in the past few decades. The three tier IP management system is introduced in ICAR as an incentive for investing in research and development, creative activities, and for extending markets for

technology and products. Among the various strategies to promote planned growth in this sector, focus was also given on promoting viable small and medium scale enterprises. However the Indian agricultural sector, despite its importance in industrialization strategy and immense potential for employment generation, confronts several problems in business development and management. In this context, business incubators which can help entrepreneurs turn their ideas into viable businesses and promote innovation, by providing business support services and resources have great scope and significance.

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Packaging of Fishery Products

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1.0 Introduction

Packaging plays a crucial role in the protection, presentation and distribution of food and other commodities from the point of manufacture until it reaches the hands of the customer. Packaging also helps in warehousing, distribution and transportation over large distances and between countries. Food spoilage and loss would be enormous without proper packaging. Advanced packaging technologies and newer packaging materials play a vital role in this period of convenience goods and large number of new products flooding the market. Consumers are now aware of different choices available to them and as such packaging is now focused on pleasing consumer's expectations unlike earlier periods were the focus was mainly on producers and distributors.

Fish is one of the most widely consumed food commodities and is highly perishable in nature. Due to its high perishable nature the fish gets spoiled quickly and it quality cannot be improved by the best package material once it is lost. Hence only fresh fish with superior quality is to be used for processing or product development. Packaging materials vary with the type of product that is to be packed. The materials have to be chosen carefully in order to enhance the shelflife of the product that is packed. The conditions like expected period of storage, temperature, humidity, light etc. have to be known in order to design a suitable packaging material. Composite films combing the properties of different packaging films are very effective to pack different products. The prime functions is to protect the product from physical damage, reduce microbial spoilage, present the product, ensure proper handling and warehousing and transportation.

2.0. Types of Packaging Material

2.1. Glass

Containers made of glass are rigid, strong and is widely used as a food packaging material. The major advantage of a glass is that being chemically inert it does not react with the food that is packed in it. Glass also does not change its properties with storage and acts as a barrier to all forms of matter. It also acts as a barrier to odours and flavors. Glass can be made in to different shapes and sizes. However, it has to be handled with care since it is highly fragile and breaks easily. Another disadvantage is that it is much heavier than other packaging materials and hence adds to the transportation cost.

2.2. Cans

Tin plate containers have been used widely for packaging since the eighteenth century. The tin cans are made up of steel (98%) and tin (2%) as coating on the inside and outside. These cans are mainly used for packaging of heat processed products. Different types of tin cans are available depending on the type of product to be packed in it. Tin free steel and aluminum cans are also used widely for packaging of food products. However, the cans have to be lacquer coated on the inside to arrive at properties like acid resistance and sulphur resistance in order for packaging of fruits and fish products. This is mainly to avoid corrosion of the cans during long term storage.

Polymer coated cans of 6 oz capacity with a universal polymer coating can be widely used for a variety of products. These cans are made from Electrochemically chromium coated steel (ECCS) plate with clear polyethylene terephtahalate (PET) coating on either side. The chromium and PET coating gives the can a greyish colour, smooth finish and glistening appearance and acts as a barrier between the product and the base steel. The top and bottom of the can is manufactured in such a way that it can be stacked vertically without risk of toppling off the shelf. The storage space requirement for the cans can also be minimised. These cans are best suitable for thermal processing of fish and fish products and other vegetable products. These cans have easy open ends. Metal cans have superior strength but are heavy and find difficulty in disposal.

2.3. Paper

Large quantities of foods are ppackaged, stored and distributed in paper based containers like boxed and laminated papers. Paper is cheap and available and it can be easily made into shapes. However, it has poor barrier properties and is highly permeable to moisture and gases.

2.3.1. Paper board

Thicker paper is called paper board and the thickness of the lightest board is 0.19mm and the heaviest is 0.125 mm. Paper boards are used for making corrugated fibre board cartons.

2.4. Polymer Packaging

Plastics offer several advantages over other packaging materials since they are lighter than most natural materials, flexible and can be made into different shapes and sizes. Plastics have excellent physical properties like tensile strength, toughness, elongation and barrier. The packaging requirements of a certain type of food may not be met by using a single packaging material. In these circumstances copolymers or laminates made of two or more different polymers having different properties can be used.

2.4.1. Low Density Polyethylene (LDPE)

Most commonly used packaging material from petroleum source, LDPE is transparent, impermeable to water vapor, heat sealable. The cost of production coat is low and hence one of the cheapest of polymers. The oxygen and carbon dioxide transmission rates of LDPE are high and can withstand temperatures ranging from – 40°C to 85°C.

2.4.2. High Density Polyethylene (HDPE)

Production of HDPE is by a low-pressure process. HDPE is stronger, thicker, less flexible and brittle and has a higher barrier to gases and moisture than LDPE. It can be heat sealed and has a high softening temperature. High molecular weight high density polythene has good mechanical strength, and better stress resistance property.

2.4.3. Linear Low Density Polythene (LLDPE)

Linear low density polythene is produced by a low pressure process. Unlike LDPE, LLDPE have superior chemical resistance, higher surface gloss. LLDPE also has good puncture resistance and tearing strength. LLDPE have led to the replacement of LDPE and HDPE in some areas.

2.4.4. Polypropylene (PP)

Polypropylene is produced by the polymerisation of propylene. It is strong, rigid and lighter polymer than polyethylene. It is mainly used for packaging of finished products. The film is transparent and clear and the products packed in it is visible

2.4.5. Polystyrene

The material is manufactured from ethylene and benzene, which are cheap. The polymer is normally atactic and it is thus completely amorphous because of the bulky nature of the benzene rings prevents a close approach of the chains. Thermoform containers using polystyrene along with EVOH and poly vinylidene chloride copolymer are developed for also used for thermoforming. It is also used in blister packs and as a breathing film for fresh products. However, it has poor heat seal strength.

2.4.6. Polyester

Polyester is a good material for food packaging due to its superior lightness, strength, gas barrier properties, resistance to chemical and capability to withstand a wide range of temperature. They can be used for boil in the bag products which are earlier frozen due to their ability to withstand high temperature. Metallised polyester is an important packaging for many consumer goods with improved barrier properties. They can also be used as microwavable containers and hence has a wide application in the food industry for such products.

2.4.7. Polyamides (Nylon)

There are different grades of Nylon. Nylons are strong, tough, crystalline materials having high melting and softening points. They are highly resistant to abrasion and has low gas barrier properties.

2.4.8. Polyvinyl Chloride (PVC)

PVC films has gloss and transparency and is widely used for stretch wrapping of trays containing fresh produce. Since the films have a high water vapour transmission rate there is no moisture condensation on the underside of the films. Plasticized PVC is rigid and is thermoformed to into containers and trays. PVC bottles have better superior clarity and barrier properties than LDPE.

2.4.10. Aluminium foil

Aluminium has excellent properties like grease and oil resistance, opacity tasteless, etc. Aluminium foils is not permeable to moisture and oxygen. In packaging applications using aluminium foils, the material is combined with a heat sealable film like polythene or polypropylene to enhance its barrier. Aluminium foil are soft and susceptible for creasing while handling. Hence they are generally used as an inner layer.

3.1. Packaging of fresh fish

Fresh fish is the most perishable of all foods. Chilling by the application of ice to the fish is done to reduce the temperature. This is the cheapest and most widely used method to keep fresh fish unspoiled. Fish is usually sold in local markets without any packaging, but for retailing and further storage packaging is of necessary. Packaging materials for fresh fish should have oxygen barrier properties to prevent dehydration, avoid permeation of odours and minimise chemical and bacterial spoilage. For bulk transportation the containers should be tough enough to withstand the transportation conditions. The packaging containers should be of light in weight, easily cleanable and have good insulation properties. High density polypropylene containers are commonly used for transportation of fish in the landing centres and fish markets. However, for longer distance transportation insulated containers are commonly used.

3.2. Packaging of frozen fish

Seafood's are a major source of export from the country. They are packed in two major forms namely, as block frozen in 2 or 4 kg each. Shrimps, squids, cuttlefish etc. are packed in low density polythene (LDPE) covers or duplex board carton lined with LDPE. Duplex cartons of fish blocks are then placed into a master poly and packed into master carton made up of corrugated fibre board boxes. The packed cartons are then stored in the cold store at -18°C

Shrimp is processed in individually quick frozen (IQF) form which is a value addition against the traditional block frozen and fetches a higher unit value. The packaging requirements of IQF shrimp are different from block frozen shrimp. IQF shrimps are mainly smaller packs for direct purchase by consumers but not bulk or institutional packs. Here there is every chance that the product may melt of dehydrate if exposed to heat or outside conditions. For IQF packaging coextruded or laminate films are used. Polyester laminated with low density polyethylene is used. Duplex carton when used, are laminated with plastic film to improve the functional properties as well as aesthetic value of the pack. In the case of block frozen shrimp, the risk of moisture loss or oxidative reaction leading to flavour changes etc. are minimal.

While storage and transportation of IQF shrimps the corrugated fibre board should have high compression strength to bear weight without damaging the project. 5/7/9 ply corrugated fibre board cartons are recommended for their packaging.

3.3. Battered and Breaded Products

These are products in a ready to cook convenient forms. Here the bulk of the product is contributed by the process of battering and breading which also helps in the reduction of overall cost. A number of value added marine products can be prepared from prawns, squids, cuttle fish, certain species of fish and minced meat from low priced fishes. They include battered and breaded peeled shrimp, battered and breaded shrimp, fantail (butterfly), battered and breaded shrimp round tail-on, battered and breaded squid rings, battered and breaded stuffed squid rings, battered and breaded stuffed squid, battered and breaded fish fillets, fish fingers, fish fingers, fish cutlets and fish patties.

The major changes taking place during frozen storage of these products are dehydration, discoloration, development of rancid flavours etc. Suitable packaging can prevent these changes and enhance the shelf life of the products. Packaging of such products in flexible plastic films alone is not advisable since they provide very little mechanical protection and there is a tendency for the products to get damaged during handling, storage and transportation. Semi rigid food grade thermoformed containers made of materials like PVC, HIPS and HDPE capable of withstanding low temperature storage can be used for packing and storing of such products.

3.4. Packaging of dried fishery products

Dryfish is a traditional product and commands a very good market. Baskets made of coconut or Palmyrah leaves or gunny bags are commonly used as containers for packing, storage and transportation of dried fish in internal markets. These packages do not offer must protection to the products and allow easy entry of pests, insects, and rodents. They are also not water proof and resistant to oxygen. Since such dried products are hygroscopic in nature the packaging material has to be resistant to water ingress. The bulk packaging materials commonly used are

bamboo baskets, gunny bags, dried Palmyrah or coconut palm leaves etc. HDPE woven gusseted bags laminated with 100-gauge low density polythene are best for bulk packaging of dried fish. This material is insect proof and can minimize the spoilage due to microbes. Low-density polythene or polypropylene are most commonly used as consumer packaging due to their lower cost and easy availability. However, they high oxygen and water vapour and gets easily damaged due to the sharp spines and bones of the dried fish. Laminate films made of polyester polythene is advisable for consumer packaging since they have good mechanical strength and oxygen and water barrier properties.

3. 5. Accelerated Freeze dried (AFD) products

Freeze drying requires high cost of machinery and operation skill. The percentage of moisture present in AFD products is being below 2. The products are very brittle and fragile, and can easily undergo oxidation, colour change and absorb moisture. Such products are usually packed in containers using an inert gas. The packaging material employed here should have low oxygen and water vapour. Rigid containers like tin cans can be used for packing such products. Flexible packaging includes laminates of paper/ aluminium foil /polythene or metallised polyester polythene laminated pouches.

3.6. Pickles

Pickle is a value added item using low fishes , prawns, clam meat etc. along with vegetable products like ginger, garlic, chilly, acetic acid etc. The most suitable packaging is glass bottles since they inert, durable, non-permeable to gases and moisture etc. At the same time, they are heavy, can break and is bulky in nature and occupies a lot of space. Flexible packaging materials are plain polyester laminated with LDPE-HDPE Co-extruded film. This material can be displayed as stand up pouches and can be printed.

3.7. Fish soup powder

Soup powder is a product containing protein, fat and other seasonings. The dried product is hygroscopic in nature and hence appropriate package is to be used for packaging and storing such products. Metallised /plain polyester films laminated with LDPE-HDPE co-extruded film is suitable for packaging of such products.

3.8. Extruded products

Ready to eat breakfast cereals, pasta, snack food, pet food, and textured vegetable protein are prepared by the extrusion process. Here the product are mainly in the ready to eat form and hence have to be hygienically packed in an inert atmosphere. The extruded products being dry are highly hygroscopic in nature. They also contain fat and can become rancid when exposed to air. They are also brittle and may powder when crushed. Hence packaging films of high barrier

to oxygen and water vapour are required. Generally extruded products are packed in LDPE/metallised polyster laminated pouches flushed with Nitrogen.

3.9. Surimi and surimi based products

Surimi is an intermediate product / raw material used for developing value added products like shrimp and crab analogues like crab claws, crab sticks, lobster tails etc. Washed fish mince of certain fishes are used to make surimi which is to be preserved frozen in rectangular blocks by the addition of cryoprotectants. The surimi should not undergo oxidative rancidity and desiccation during storage and hence packaging materials with low water vapour permeability and low permeability to gases and odours are to be used. The packaging material should be strong enough to withstand stress during handling, storage and distribution. LDPE and HDPE films can be used for packaging and frozen storage of surimi.

3.10. Fish Sausage

Sausage is a fish mince based product. Surimi or raw fish mince is the base material, which is mixed with several other ingredients. Fish sausage is processed in casings made of cellulose, collagen and fibrous casing strengthened by fibers. The synthetic casings like polyamide or polypropylene have to be removed before consumption. For thermal processing polypropylene casings are used to withstand high temperatures.

3.11. Glucosamine hydrochloride

D-Glucosamine hydrochloride is used to cure rheumatic arthritis, and is also used as an additive in the food & cosmetic industry. D-Glucosamine hydrochloride should be kept dry in a well-closed container, with temperature lower than 25°C, and RH 50%. Glucosamine is packed in PP or HDPE containers of 1kg, 500g and 20 g, 1kg metallised bag, 25kg HDPE drums for commercial use and smaller quantities are packed in auto sample vials.

3.12. Chitin and Chitosan

Chitin and chitosan are derived from prawn shell waste and is exported in large quantities. The product should be protected against moisture, pest attacks and microbial spoilage. Packaging of chitosan is done in HDPE woven gusseted bag laminated with 100 gauge LDPE liner for commercial trade. Chitosan is also marketed in capsule forms for consumption. Capsules made of gelatin are used for filling chitosan powder. A particular quantity of capsules are then placed in HDPE containers.

3.13. Fish Hydrolysate

Fish Hydrolysate is prepared from fish mince which contain oil and is a food source for microbes. It is generally cold-processed and hence retains the amino acids and protein chains as such. Fish hydrolysate is concentrated, and when diluted can be used ideally as a manure for

crops and vegetation. It is rich in major nutrients and trace elements. It can be used as a foliar spray, but since the oil is present it may show patches on the leaves. The liquid is generally packed in jars or cans which are made of polypropylene or HDPE.

3.14. Fish Meal

Fish meal is a source of high quality protein (60%) and is rich in omega-3 essential fatty acids. Incorporation of DHA and EPA in fish meal will ensure its concentration in the diets of fish and poultry, ultimately reaching the human diet. Hence the packaging should be impermeable to moisture, oxygen and other insets and pests. Fish meal is generally packed in HDPE sacks for bulk transportation. The fishmeal whether in ground or pelletised form should contain moisture 6-12 %. The fat content should not exceed 18% and the final meal should contain at least 100 ppm antioxidant (ethoxyquin). If the temperature exceeds°130 F or 55° C then the ventilation should be kept on hold. The fish meal is generally packed in jute bags, multiwall paper bag which are lined with polythene and in HDPE woven bags with liner.

3.15. Fish oils

Fish oils are highly unsaturated and easily susceptible to oxidation when exposed to air. Hence they have to be packed in containers which have high barrier properties which are moisture proof, oil resistant and impermeable to oxygen. Larger quantities of fish oil are mainly packed in LLDE/Nylon films or in glass bottles. Bulk transportation food grade flexitanks made of 4 layered polyethylene and tubular PP. Advantages of using flexitanks are that they can carry 50% more than bottles and therefore will save on storage space, packaging and transportation cost.

Fish oil is also marketed for regular oral dosage in the form softgel capsules. The shell is made of gelatin, water, glycerol or sorbitol. The process of encapsulation is by using the rotary die encapsulation process. After encapsulation, the soft gels are further dried depending on the product. They are then further packed in glass or plastic bottles. The soft gels are also packed as blister packs.

3.16. Fish silage

Fish silage is a made from whole fish or parts of the fish which are mainly processing discards and to which an acid is added. The liquefaction of the fish is brought about by enzymes inherent in the fish. The product is a stable liquid and contains all the water present in the original material. Hence it is in the liquid form. Fish silage is generally stored in huge drums or polycontainers so that they can be transported.

3.17. Shark fin rays

Shark fin is traditionally exported item from India in the dried form . packaging materials hhaving good puncture resistance and mechanical strength and good barrier properties are the major requirements for packaging of shark fin rays. Polyester/ LD polythene laminates or Nylon based co-extruded films having good puncture resistance are most suitable for packaging. Traditionally bulk packing of dried shark fins were undertaken in jute sacks whereas now high-density polythene woven sack or polypropylene woven sack is used..

4. Conclusion

Packaging is vital for storage and transportation of any product. It also plays a crucial role in the shelf life extension of the product. Packaging requirements vary depending on the type of fishery products to be packed and has to be designed accordingly. Packaging helps in marketing and sale of the product and has to be designed and labelled as per standard regulations.

Seafood quality assurance and safety regulations

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

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

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

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

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

- presence of Ciguatera toxin in reef dwelling finfish
- histamine fish poisoning
- norovirus and *Vibrio parahaemolyticus*in raw shellfish
- Salmonella in shrimp products
- *Clostridium botulinum*in processed products
- high level of environmental pollutants
    - mercury, cadmium, lead
    - polychlorinated biphenyls and pesticides
- antimicrobial residues in aquaculture products

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

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

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

mostly due to presence of high load of mesophilic bacteria, coliforms, pathogens and presence of crystal violet.

Genesis of Food Safety Standards and Regulations

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

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

Salient features of some Export regulations related to Seafood

European Union

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

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

Regulation: A binding legislative act applied in entirety across EU

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

USA

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

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

United States Fisheries and Wildlife Service (USFWS) is also involved in regulation of import and export of shellfish and fishery products through Convention on International Trade in

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

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

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

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

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

- evaluate hazards that could affect food safety;
- Identify and implement preventive controls to prevent hazards;

- Monitor controls and maintain monitoring records; and
- Conduct verification activities

Sec. 106.Protection against intentional adulteration

Sec. 111. Sanitary Transportation of Food

Sec. 301. Foreign supplier verification program

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

Sec. 302. Voluntary qualified importer program

- Allows for expedited review and entry; facility certification required

Sec. 303. Certification for high-risk food imports

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

Sec. 304. Prior notice of imported food shipments

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

Sec. 307. Accreditation of third-party auditors

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

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

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

Sec. 309. Smuggled Food

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

China

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

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

Russia

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

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

Japan

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

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

- Food Sanitation Act (Act No.233, 1947): Latest Revision on June 5, 2009, Act No. 49)
- Specifications and Standards for Food and Food Additives, Latest Revision on September 6, 2010, MHLW Notification No. 336
- Japan's Specifications and Standards for Food Additives" (Eighth Edition). Published by the Ministry of Health, Labour and Welfare in 2007
- Food Safety Basic Act (Act No. 48, 2003)
- Agricultural Chemicals Regulation Law (Law No. 82, 1948)

Codex Alimentarius Commission

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

- Joint Expert Committee on Food Additives (JECFA)
- Joint Meeting on Pesticide Residues (JMPR)
- Joint Meeting on Microbiological Risk Assessment (JEMRA)

Different subject committees and commodity committees, adhoc inter-governmental task forces and regional coordinating committees function and under codex. Codex Committee on Fish and Fisheries Products (CCFFP) is entrusted with the task of formulating standards for different product categories. Although Codex standards on Fish and Fishery Products specifically

do not address food safety requirements, but provide a strong framework for production, hygienic requirements and sampling.

Available Codex Standard for Fish and Fishery Products

1.	Standard for Canned Salmon	CODEX STAN 3-1981
2.	Standard for Quick Frozen Finfish, Eviscerated or Uneviscerated	CODEX STAN 36-1981
3.	Standard for Canned Shrimps or Prawns	CODEX STAN 37-1981
4.	Standard for Canned Tuna and Bonito	CODEX STAN 70-1981
5.	Standard for Canned Crab Meat	CODEX STAN 90-1981
6.	Standard for Quick Frozen Shrimps or Prawns	CODEX STAN 92-1981
7.	Standard for Sardines and Sardine-Type Products	CODEX STAN 94-1981
8.	Standard for Quick Frozen Lobsters	CODEX STAN 95-1981
9.	Standard for Canned Finfish	CODEX STAN 119-1981
10.	Standard for Quick Frozen Blocks of Fish Fillets, Minced Fish Flesh and Mixtures of Fillets and Minced Fish Flesh	CODEX STAN 165-1989
11.	Standard for Quick Frozen Fish Sticks (Fish Fingers), Fish Portions and Fish Fillets - Breaded or in Batter	CODEX STAN 166-1989
12.	Standard for Salted Fish and Dried Salted Fish of the Gadidae Family of Fishes	CODEX STAN 167-1989
13.	Standard for Dried Shark Fins	CODEX STAN 189-1993
14.	General Standard for Quick Frozen Fish Fillets	CODEX STAN 190-1995
15.	Standard for Quick Frozen Raw Squid	CODEX STAN 191-1995
16.	Standard for Crackers from Marine and Freshwater Fish, Crustaceans and Molluscan Shellfish	CODEX STAN 222-2001
17.	Standard for Boiled Dried Salted Anchovies	CODEX STAN 236-2003
18.	Standard for Salted Atlantic Herring and Salted Sprat	CODEX STAN 244-2004
19.	Standard for Sturgeon Caviar	CODEX STAN 291-2010
20.	Standard for Live and Raw Bivalve Molluscs	CODEX STAN 292-2008
21.	Standard for Fish Sauce	CODEX STAN 302-2011

Code of Practice

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

Guidelines

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

Guidelines on the Use of Mass Spectrometry (MS) for Identification, Confirmation and Quantitative Determination of Residues	CAC/GL 56-2005

Codex standard applicable to Fish and Fishery Products

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

Bureau of Indian Standards (BIS)

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

BIS Standards on Fish and Fishery Products

IS 2168	1971	Pomfret Canned in Oil
IS 2236	1968	Prawns/Shrimp Caned in Brine
IS 2237	1997	Prawns (Shrimps) – Frozen
IS 3336	1965	Shark Liver Oil for Veterinary Use
IS 3892	1975	Frozen Lobster Tails
IS 4304	1976	Tuna Canned in Oil
IS 4780	1978	Pomfret, Fresh
IS 4793	1997	Whole Pomfret – Frozen
IS 5734	1970	Sardine Oil
IS 6121	1985	*Lactarius*sp Canned in Oil
IS 6122	1997	Seer Fish (*Scomberomorus* Sp.) - Frozen
IS 6123	1971	Seer Fish (*Scomberomorus* spp.), Fresh
IS 7143	1973	Crab Meat Canned in Brine
IS 7313	1974	Glossary of Important Fish Species of India
IS 7582	1975	Crab Meat, Solid Packed
IS 8076	2000	Frozen Cuttlefish and Squid

IS 9808	1981	Fish Protein Concentrate
IS 10059	1981	Edible Fish Powder
IS 10760	1983	Mussels Canned in Oil
IS 10762	1983	Tuna Canned in Curry
IS 10763	1983	Frozen Minced Fish Meat
IS 11427	2001	Fish and Fisheries Products - Sampling
IS 14513	1998	Beche-de-mer
IS 14514	1998	Clam Meat – Frozen
IS 14515	1998	Fish Pickles
IS 14516	1998	Cured fish and fisheries products - Processing and storage - Code of Practice
IS 14517	1998	Fish Processing Industry - Water and Ice - Technical Requirements
IS 14520	1998	Fish Industry - Operational Cleanliness and layout of market - Guidelines (Amalgamated Revision of IS 5735, 7581 and 8082)
IS 14890	2001	Sardines - Fresh, Frozen and Canned (Amalgamated revision of IS 2421, 6677,8652,8653, 9750 and 10761
4891	2001	Mackerel - Fresh, Frozen and Canned (Amalgamated Revision of IS 2420, 3849,6032, 6033 and 9312)
IS 14892	2000	Threadfin - Fresh and Frozen
IS 14949	2001	Accelerated Freeze Dried Prawns (Shrimps) (Amalgamated revision of IS 4781 and 4796
IS 14950	2001	Fish - Dried and Dry-Salted

Food Safety and Standards Authority of India (FSSAI)

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

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

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

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

HACCP CONCEPT IN SEAFOOD QUALITY ASSURANCE

Concept of HACCP was developed in the late 1950s and initiated in the early 1960s by the Pillsbury Company, in collaboration with NASA and the Natick Laboratories of the U.S. Army, and the U.S. Air Force Space Laboratory Project Group. The concepts designed were based on the principles of Failure Mode and Effect analysis (FEMA). It was first presented to regulatory community during National Conference on Food Protection in 1971 by Howard Bauman of the Pillsbury Company and first applied to low acid canned foods in 1974. In 1980s, other food processing companies embraced it voluntarily and at the same time FDA and USDA continued regulatory interest. HACCP gained regulatory approval from USFDA and USDA after it was endorsed by National Academy of Sciences and further by 9National Advisory Committee on Microbiological Specifications of Foods (NACMSF). On December 18, 1995, The Food and Drug Administration (FDA) published as a final rule 21 CFR 123, "Procedures for the Safe and Sanitary Processing and Importing of Fish and Fishery Products" that requires processors of fish and fishery products to develop and implement Hazard Analysis Critical Control Point (HACCP) systems for their operations. The regulation became effective December 18, 1997. HACCP was recommended by Codex Alimentarius Commission (CAC) in 1997 which is recognized as "Recommended International Code of Practice-General Principles of Food Hygiene" (CAC/RCP 1-1969, Rev 3, 1997). In European countries, the EU Directive 93/43/EEC mandated the implementation of HACCP in all local legislation by December 1995. Subsequently the EC hygiene regulations 852/2004 and 853/2004 mandated that all food business operators should establish and operate food safety programmes and procedure based on HACCP principles. Since then HACCP has gained acceptance by many countries in Europe, Canada, New Zealand, Australia, Central and South America and many Asian countries. In India voluntary HACCP standards are given by Bureau of Indian Standards (IS 15000:1998)

Hazard Analysis Critical Control Point (HACCP)

The HACCP system is an internationally recognized system used to manage food safety. It has been endorsed by the *Codex Alimentarius Commission* as a tool that can be used to systematically identify hazards specific to individual products and processes and describe measures for their control to ensure the safety of fish and fish products. It is a dynamic system, capable of accommodating change in the system viz., changes in equipment design, processing procedures and technological advancements.

HACCP is defined as a system which identifies, evaluates, and controls hazards which are significant for food safety

HACCP is a structured, systematic approach for the control of food safety throughout the food system, from the farm to fork. It requires a good understanding of the relationship between cause and effect in order to be more pro-active. HACCP is supported by pre-requisite

programmes like Good Manufacturing Practice (GMP), Good Hygienic Practices (GHP), SSOP (Sanitation standard operating procedures), Good Agricultural Practices (GAP), and Good Storage Practices (GSP), etc.

Pre-requisite programmes

Prerequisite programs provide a foundation for an effective HACCP system. They are often facility-wide programs rather than process or product specific. They reduce the likelihood of certain hazards. Prerequisite programs set the stage for a HACCP system and provide on-going support for the establishment's food safety system. They keep potential hazards from becoming serious enough to adversely impact the safety of foods produced. Without clean working conditions free from microbiological, chemical, and physical contamination from many sources, a HACCP plan cannot be effective.

Prerequisite programmes are practices and conditions needed prior to and during the implementation of HACCP and which are essential for food safety -WHO

Some of the prerequisite programmes include GAP, GMP and GHP which must be working effectively within a commodity system before HACCP is applied. Establishments should revise their prerequisite programs, as necessary, to ensure their effectiveness, and should take appropriate corrective actions when they determine that their prerequisite programs may have failed to prevent contamination and/or adulteration of product. Good Agricultural Practices are "practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products" (FAO)

The Good Manufacturing Practices commonly referred as current good manufacturing practices (cGMPs, 21 CFR 110) give details as to what specific procedures must be followed to comply with the regulation. Standard operating procedures (SOPs) are the steps your company takes to assure that the GMPs are met. They include stepwise procedures, employee training, monitoring methods, and records used by your company. Similarly, SSOP covers eight key sanitation conditions as required by USFDA.

Good hygiene practices include all practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain

Basic principles of HACCP

There are seven discrete activities that are necessary to establish, implement and maintain a HACCP plan, and these are referred to as the 'seven principles' in the Codex Guideline (1997). The seven Principles of HACCP are

Principle 1: **Conduct a hazard analysis.**

Hazard: A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Hazard analysis: The process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for food safety and therefore should be addressed in the HACCP plan.

Principle 2: **Determine the Critical Control Points (CCPs)**

A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Principle 3: **Establish critical limits.**

A criterion which separates acceptability from unacceptability, when monitoring a critical control point.

Principle 4: **Establish a monitoring system**

The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control.

Principle 5: **Establish a procedure for corrective action,**

Any action to be taken when the results of monitoring at the CCP indicate a loss of control.

Principle 6: **Establish procedures for verification**

The application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan.

Principle 7: **Establish documentation concerning all procedures and records appropriate to these principles and their application**

Developing a HACCP plan (FAO guidelines)

The all-important principles form the essential requirements of a food safety system and are designed to ensure that enough precaution is taken so that any hazard which can interfere with consumer health is addressed. The first principle of HACCP is hazard analysis. But understanding the product thoroughly is extremely important to get an idea on the possible hazards which could be associated with the product so that appropriate action can be taken to control or minimize the hazard. The seven principles of HACCP are usually carried out in twelve steps, as given below.

Step 1 - Establish a HACCP team

Hazard profile is related to the commodity. Therefore in order to understand fully the commodity, to identify the hazards associated, the CCP and to work out a control measures it is pertinent to have a team which has the knowledge about the product or commodity, its production process and shelf-life. This would facilitate the proper implementation of HACCP for the production of the product. Therefore, it is important that the HACCP team is made up of people from a wide range of disciplines. The team should include:

- A team leader to lead the group and direct the team to carry out the work as per the system requirements. He should be well versed with the techniques and manage the team members to contribute to the cause.
- A person conversant with the production system who knows full details of the flow of production.

- Persons from varied field viz., biochemist, microbiologist, toxicologist, quality control manager or an engineer with an understanding of particular hazards and associated risks.
- Others who are involved in the varied activates of the system viz., packaging specialists, raw material buyers, distribution staff or production staff, farmers, brokers, who are involved with the process, and have working knowledge of it in order to provide expert opinion.
- Possibly one person to help the team with secretarial requirements.

Task 2 - Describe the product

Understanding the product is the important step as the hazard associated with depends on the product. To start a hazard analysis, a full description of the product, including customer specification, should be prepared. This should include information relevant to safety, regulation/target level, and composition, physical/chemical properties of the raw materials and the final product, the water activity of the product (a_w), the pH etc. There should information on the packaging, storage and distribution as well as information on the temperature of storage, distribution, labelling information and shelf-life of the product. This information helps the audit team to understand the possible hazards and their control measures.

Task 3 - Identify the product's intended use

Information on the intended use of the commodity or product as well as the information on the mode of consumption viz., direct consumption, cooked before hazard analysis will have bearing on the hazard analysis. The nature of the target group for the product may also be relevant, particularly if it includes susceptible groups such as infants, the elderly, and the malnourished. The likelihood of misuse of a product should also be considered, such as the use of pet food as a human food, either by accident or design.

Task 4 - Draw up the commodity flow diagram

The first function of the team is inspect the detailed commodity flow diagram (CFD) of the commodity system and the expertise of the production manager or product expert is important at this stage as far as hazard analysis is concerned.

Task 5 - On site confirmation of flow diagram

After studying the commodity flow diagram the team should visit the system where HACCP is implemented or proposed to be implemented which may include any step in the production viz., procurement of raw material, store, production area, packaging area, storage section where the product is kept before distribution, nature of distribution, conditions of distribution etc. The is known as 'walking the line ', a step by step checking to get information on whether relevant requirements of the system are considered while making the production line.

The site for which the HACCP plan is being designed should be visited as many times as possible to ensure that all relevant information has been collected.

Task 6 - Identify and analyse hazard(s) - (Principle 1)

Effective hazard identification and hazard analysis are the keys to a successful HACCP Plan. All real or potential hazards that may occur in each ingredient and at each stage of the commodity system should be considered. Food safety hazards for HACCP programmes have been classified into three types of hazards:

- Biological: typically foodborne bacterial pathogens such as *Salmonella*, *Listeria* and *E. coli*, also viruses, algae, parasites and fungi.
- Chemical: There are three principle types of chemical toxins found in foods: naturally occurring chemicals, e.g. cyanides in some root crops, and allergenic compounds in peanuts; toxins produced by micro-organisms, e.g. mycotoxins, and algal toxins; and chemicals added to the commodity by man to control an identified problem, e.g fungicides or insecticides.
- Physical: contaminants such as broken glass, metal fragments, insects or stones.

The probability that a hazard will occur is called a risk. The risk may take a value from zero to one depending on the degree of certainty that the hazard will be absent or that it will be present. After hazard identification, a hazard analysis must be conducted to understand the relative health risk to man or animal posed by the hazard. It is a way of organizing and analysing the available scientific information on the nature and size of the health risk associated with the hazard. The risk may have to be assessed subjectively and simply classified as low, medium, or high.

Once a food safety hazard has been identified, then appropriate control measures should be considered. These are any action or activity that can be used to control the identified hazard, such that it is prevented, eliminated, or reduced to an acceptable level. The control measure may also include training of personnel for a particular operation, covered by GAP, GMP, and GHP.

Task 7 - Determine the critical control points (CCPs) - (Principle 2).

Each step in the commodity flow diagram, within the scope of the HACCP study, should be taken in turn and the relevance of each identified hazard should be considered. The team must determine whether the hazard can occur at this step, and if so whether control measures exist. If the hazard can be controlled adequately, and is not best controlled at another step, and is essential for food safety, then this step is a CCP for the specified hazard.

If a step is identified where a food safety hazard exists, but no adequate control measures can be put in place either at this step or subsequently, then the product is unsafe for human consumption. Production should cease until control measures are available and a CCP can be introduced.

Task 8 - Establish critical limits for each CCP - (Principle 3)

Critical limits must be specified and validated for each CCP. Criteria often used include measurements of temperature, time, moisture level, pH, water activity, and sensory parameters such as visual appearance. All critical limits, and the associated permissible tolerances, must be documented in the HACCP Plan Worksheet, and included as specifications in operating procedures and work instructions.

Task 9 - Establish a monitoring procedure - (Principle 4)

Monitoring is the mechanism for confirming that critical limits at each CCP are being met. The method chosen for monitoring must be sensitive and produce a rapid result so that trained operatives are able to detect any loss of control of the step. This is imperative so that corrective action can be taken as quickly as possible so that loss of product will be avoided or minimized.

Monitoring can be carried out by observation or by measurement, on samples taken in accordance with a statistically based sampling plan. Monitoring by visual observation is basic but gives rapid results, and can therefore be acted upon quickly. The most common measurements taken are time, temperature and moisture content.

Task 10 - Establish corrective action - (Principle 5)

If monitoring indicates that critical limits are not being met, thus demonstrating that the process is out of control, corrective action must be taken immediately. The corrective action should take into account the worst case scenario, but must also be based on the assessment of hazards, risk and severity, and on the final use of the product. Operatives responsible for monitoring CCPs should be familiar with and have received comprehensive training in how to effect a corrective action.

Corrective actions must ensure that the CCP has been brought back under control. Corrective action can then be applied to pre-empt a deviation and prevent the need for any product disposition.

Task 11 - Verify the HACCP plan - (Principle 6)

Once the HACCP plan has been drawn up, and all of the CCPs have been validated, then the complete plan must be verified. Once the HACCP plan is in routine operation, it must be verified and reviewed at regular intervals. This should be a task of the person charged with the responsibility for that particular component of the commodity system. The appropriateness of CCPs and control measures can thus be determined, and the extent and effectiveness of monitoring can be verified. Microbiological and/or alternative chemical tests can be used to confirm that the plan is in control and the product is meeting customer specifications. A formal

internal auditing plan of the system will also demonstrate an ongoing commitment to keep the HACCP plan up to date, as well as representing an essential verification activity.

Task 12 - Keep record - (Principle 7)

Record keeping is an essential part of the HACCP process. It demonstrates that the correct procedures have been followed from the start to the end of the process, offering product traceability. It provides a record of compliance with the critical limits set, and can be used to identify problem areas. Records that should be kept include: all processes and procedures linked to CCP monitoring, deviations, and corrective actions.

Steps involved in developing HACCP system

(Based on Codex 1997)

Step 1.	Assemble HACCP team	Preliminary Steps
Step 2.	Describe product	
Step 3.	Identify intended use	
Step 4.	Construct flow diagram	
Step 5.	On-site confirmation of flow diagram	
Step 6.	Conduct hazard analysis	HACCP Principle I
Step 7.	Determine Critical Control Points	HACCP Principle II
Step 8.	Establish critical limits for each CCP	HACCP Principle III
Step 9.	Establish a monitoring system for each CCP	HACCP Principle IV
Step 10.	Establish corrective actions	HACCP Principle V
Step 11.	Establish verification procedures	HACCP Principle VI
Step 12.	Establish Documentation and Record Keeping	HACCP Principle VII

HACCP is a core component in all national and international food safety standards such as IS 15000, ISO 22000:2005, USFDA Seafood HACCP regulation (CFR 123, Title 21), Dutch HACCP, BRC Global Standard for Food, SQF 2000, IFS, etc. Hence understanding concepts of HACCP would help in easy implementation of any food safety standard(s) deemed necessary to ensure safety of fish and fishery products.

Definitions in HACCP

Control (verb): To take all necessary actions to ensure and maintain compliance with criteria established in the HACCP plan.

Control (noun): The state wherein correct procedures are being followed and criteria are being met.

Control measure: Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Corrective action: Any action to be taken when the results of monitoring at the CCP indicate a loss of control.

Critical Control Point (CCP): A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical limit: A criterion which separates acceptability from unacceptability, when monitoring a critical control point.

Deviation: Failure to meet a critical limit.

Flow diagram: A systematic representation of the sequence of steps or operations used in the production or manufacture of a particular food item.

HACCP plan: A document prepared in accordance with the principles of HACCP to ensure control of hazards which are significant for food safety in the segment of the food chain under consideration.

Hazard: A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Hazard analysis: The process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for food safety and therefore should be addressed in the HACCP plan.

Monitor: The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control.

Step: A point, procedure, operation or stage in the food chain including raw materials, from primary production to final consumption.

Validation: Obtaining evidence that the elements of the HACCP plan are effective.

Verification: The application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan.

Thermal Processing of Fishes

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Preservation is the process achieved to store food for storing longer duration. Human beings are dependent on products of plant and animal origin for food. As most of these products are readily available only during certain seasons of the year and fresh food spoils quickly, methods have been developed to preserve foods. Preserved foods can be eaten long after the fresh products would normally have spoiled. Preservation must be seen as a way of storing excess foods that are abundantly available at certain times of the year, so that they can be consumed in times when food is scarce.

Fish and shellfishes pass through a number of processing stages immediately after catch before it is consumed or sold for consumption. These processes can be divided into primary processing and secondary processing. Primary processing includes the steps that enable fish to be stored or sold for further processing, packaging and distribution. Examples include washing, cleaning, heading, gilling, scaling, gutting, grading, filleting, de-boning, skinning, chilling and freezing, whereas secondary processing includes the production of 'value-added products'. Examples are salting, drying, smoking, canning, marinating and packaged ready to eat foods. There are number of reasons for processing fish and shellfish which are given below.

1. To supply safe food
2. To minimize loss/waste of valuable food commodity
3. To meet consumer preference and specified quality standards
4. To extend the shelf life of food for longer duration
5. To make profit by adding value and increasing convenience to the consumer

Fresh fish will spoil very quickly due to its internal and external factors. Once the fish has been caught, spoilage progresses rapidly. In the high ambient temperatures of the tropics, fish will spoil within few hours. The storage life of fishery products can be increased by adopting good fishing techniques (to minimize fish damage) and cooling the fish immediately to minimize the spoilage of caused by enzymatic, bacterial action and oxidation process. Fish spoilage can be effectively minimized if the effects of enzymes, bacteria and oxidation are controlled properly. This can be achieved by understanding the optimum conditions that enzymes, bacteria and oxidation processes prefer and modifying these conditions. Many processing techniques aim to alter these conditions to achieve preservation. Some of the approaches are given in Table 1.

Table 1. Possible preservation approaches

Approaches	*Examples of process*
Low temperature	Chilling, Refrigeration, Freezing
High temperature	Pasteurization, Thermal processing, smoking
Reduced water availability	Drying, salt curing, spray drying, freeze drying
Chemical based preservation	Organic acids, natural extracts from plants
Microbial product based	Bacteriocins
Radiation	Ionizing (Gamma rays) and non-ionizing (UV rays) radiation
Hurdle technology	Altered atmosphere (vacuum and modified atmosphere with CO_2, O_2, N_2 and other gases); active packaging; high pressure treatment; smoking etc

The demand for better quality processed food is ever increasing. This led to the development of a large food preservation industry aiming to supply food that is sterile, nutritious and economical. Thermal sterilization of foods is the most significant part of this industry and is one of the most effective means of preserving our food supply. 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. The concept of thermal processing has come a long way since the invention of the process by French confectioner, Nicholas Appert. Later on Bigelow and Ball developed the scientific basis for calculating the sterilization process for producing safe foods. Today, thermal processing forms one of the most widely used method of preserving and extending shelf life of food products including seafood's. Thermal processing involves application of high temperature treatment for sufficient time to destroy all the microorganisms of public health and spoilage concerns. Normally, thermal processing is not designed to destroy all microorganisms in a packaged product, which may result in low quality product which destroys important nutrients. Instead of this, the pathogenic microorganisms in a hermetically sealed container are destroyed by heating and a suitable environment is created inside the container which does not support the growth of spoilage type microorganisms. Several factors must be considered for deciding the extent of heat processing which include,

a) type and heat resistance of the target microorganism, spore, or enzyme present in the food
b) pH of the food
c) heating conditions
d) thermo-physical properties of the food and the container shape and size
e) storage conditions

Thermal processing is designed to destroy different microorganisms and enzymes present in the food. Normally in thermal processing, exhausting step is carried out to before sealing the containers. In some cases, food is vacuum packed in hermetically sealed containers. In such cases very low levels of oxygen is intentionally achieved. Hence, the prevailing conditions are not favorable for the growth of microorganisms that require oxygen (obligate aerobes) to create food spoilage or public-health problems. Further, the spores of obligate aerobes are less heat resistant than the microbial spores that grow under anaerobic conditions (facultative or obligate anaerobes). The growth and activity of these anaerobic microorganisms are largely pH dependent. From a thermal-processing standpoint, foods are divided into three distinct pH groups which are given below. Changes in the intrinsic properties of food, mainly salt, water activity and pH are known to affect the ability of microorganisms to survive thermal processes in addition to their genotype. Due to health related concerns on the use of salt, there is increased demand to reduce salt levels in foods. The United States Food and Drug Administration (FDA) have classified foods in the federal register (21 CFR Part 114) as follows (Table 2):

1. high-acid foods (pH < 3.7; e.g., apple, apple juice, apple cider, apple sauce, berries, cherry (red sour), cranberry juice, cranberry sauce, fruit jellies, grapefruit juice, grapefruit pulp, lemon juice, lime juice, orange juice, pineapple juice, sour pickles, vinegar)
2. acid or medium-acid foods (pH 3.7 - 4.5; e.g., fruit jams, frit cocktail, grapes, tomato, tomato juice, peaches, piento, pineapple slices, potato salad, prune juice, vegetable juice)
3. low-acid foods (pH > 4.5; e.g., all meats, fish and shellfishes, vegetables, mixed entries, and most soups).

Table 2. Approximate pH range of different food

Food	pH	Food	pH
Lemon juice	2.0 - 2.6	Sweet potato	5.3 – 5.6
Apples	3.1 - 4.0	Onion	5.3 – 5.8
Blueberries	3.1 – 3.3	Spinach	5.5 – 6.8
Sauerkraut	3.3 – 3.6	Beans	5.6 – 6.5
Orange juice	3.3 – 4.2	Soybeans	6.0 – 6.6
Apricot	3.3 – 4.0	Mushroom	6.0 – 6.7

Bananas	4.5 – 5.2	Clams	6.0 – 7.1
Beef	5.1 – 7.0	Salmon	6.1 – 6.3
Carrot	4.9 – 5.2	Coconut milk	6.1 – 7.0
Green pepper	5.2 – 5.9	Milk	6.4 – 6.8
Papaya	5.2 – 6.0	Chicken	6.5 – 6.7
Tuna	5.2 – 6.1	Whole egg	7.1 – 7.9

The acidity of the substrate or medium in which micro-organisms are present is an important factor in determining the extent of heat treatment required. With reference to thermal processing of food products, special attention should be devoted to *Clostridium botulinum* which is a highly heat resistant mesophilic gram positive, rod shaped spore-forming anaerobic pathogen that produces the toxin *botulin*. It has been generally accepted that *C. botulinum* and other spore forming, human pathogens does not grow and produce toxins below a pH of 4.6. The organisms that can grow in such acid conditions are destroyed by relatively mild heat treatments. For food with pH values greater than 4.5, which are known as low-acid products which includes fishery products, it is necessary to apply a time–temperature regime sufficient to inactivate spores of *C. botulinum* which is commonly referred to as a *botulinum cook* in the industry. Thermal processes are calibrated in terms of the equivalent time the thermal centre of the product, i.e. the point of the product in the container most distant from the heat source or cold spot, spends at 121.1°C, and this thermal process lethality time is termed the F_0 value. Although there are other microorganisms, for example *Bacillus stearothermophilus*, *B. thermoacidurans,*and *C. thermosaccolyaticum*, which are *thermophilic* in nature (optimal growth temperature ~ 50–55°C) and are more heat resistant than *C. botulinum a* compromise on the practical impossibility of achieving full sterility in the contents of a hermetically sealed container during commercial heat processing, whereby the initial bacterial load is destroyed through sufficient decimal reductions to reduce the possibility of a single organism surviving to an acceptably low level. This level depends on the organism, usually *Clostridium botulinum*, which the process is designed to destroy. The time required to reduce the number of spores of this organism (or any other micro-organism) by a factor of 10 at a specific reference temperature (121.1°C) is the decimal reduction time, or *D* value, denoted D_0. The D_0 value for *Clostridium botulinum* spores can be taken as 0.25 minutes. To achieve a reduction by a factor of 10^{12}, regarded as an acceptably low level, requires 3 minutes at 121.1°C, and is known as the process value, or *F* value, designated F_0 so, in this case, $F_0 = 3$, which is known as a botulinum cook which is the basis of commercial sterility.

Thermal resistance of microorganisms

For establishing a safe thermal processing, knowledge on the target microorganism or enzyme, its thermal resistance, microbiological history of the product, composition of the product and storage conditions are essential. After identifying the target microorganism, thermal resistance of the microorganism must be determined under conditions similar to the container.

Thermal destruction of microorganism generally follow a first-order reaction indicating a logarithmic order of death i.e., the logarithm of the number of microorganisms surviving a given heat treatment at a particular temperature plotted against heating time (survivor curve) will give a straight line (Figure 1). The microbial destruction rate is generally defined in terms of a decimal reduction time (D value) which represents a heating time that results in 90% destruction of the existing microbial population or one decimal reduction in the surviving microbial population. Graphically, this represents the time between which the survival curve passes through one logarithmic cycle (Fig. 1). Mathematically,

$$D = (t_2 - t_1) / (\log a - \log b)$$

where, *a* and *b* are the survivor counts following heating for t_1 and t_2 min, respectively. As the survivor or destruction curve follows the logarithmic nature, the complete destruction of the microorganisms is theoretically not possible.

From the survivor curve, as the graph is known, it can be seen that the time interval required to bring about one decimal reduction, i.e. 90% reduction in the number of survivors is constant. This means that the time to reduce the spore population from 10,000 to 1000 is the same as the time required to reduce the spore population from 1000 to 100. This time interval is known as the decimal reduction time or the 'D' value. The D value for bacterial spores is independent of initial numbers, but it is affected by the temperature of the heating medium. The higher the temperature, faster the rate of thermal destruction and lower the D value. The unit of measurement for D is 'minute'. An important feature of the survivor curve is that no matter how many decimal reductions in spore numbers are brought about by a thermal process, there will always be some probability of spore survival. Different micro-organisms and their spores have different D values as shown in Table–3.

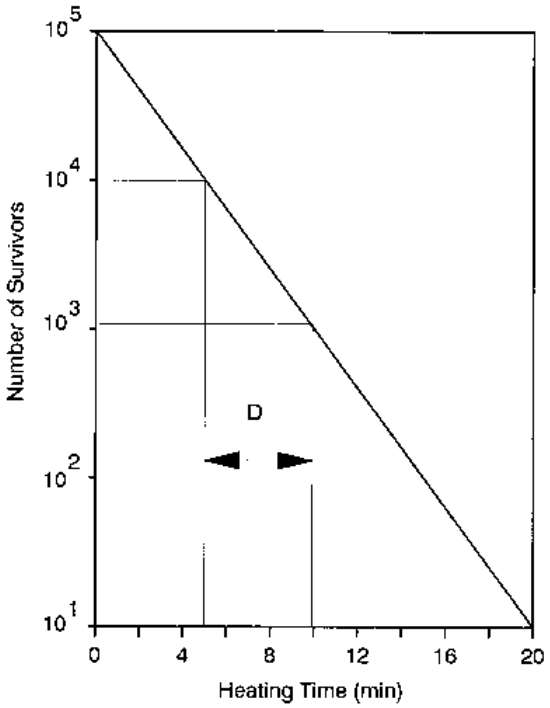


Fig 1. Survivor curve

Table-3. D value (at 121.1°C) of some bacterial spores

Microorganism	Optimum growth temperature (°C)	D value (min)
Bacillus stearothermophilus	55	4 to 5
Clostridium thermosaccharolyticum	55	3 to 4
Clostridium nigrificans	55	2 to 3
Clostridium botulinum types A & B	37	0.1 to 0.25
Clostridium sporogenes (PA 3679)	37	0.1 to 1.5
Bacillus coagulans	37	0.01 to 0.07
Non spore forming mesophilic bacterial yeasts and moulds	30 - 35	0.5 to 1.0

The thermal death time may be defined as the time required at any specified temperature to inactivate an arbitrarily chosen proportion of the spores, the higher the proportion the greater will be the margin of safety. TDT is the heating time required to cause complete destruction of a microbial population. Such data are obtained by subjecting a microbial population to a series of heat treatments at a given temperature and testing for survivors. The thermal death time curve is obtained by plotting the thermal death time on logarithmic scale against temperature of heating on linear scale on a semilogarithmic graph paper (Fig. 2). Comparing TDT approach with the decimal reduction approach, one can easily recognize that the TDT value depends on the initial microbial load (while D value does not). Further, if TDT is always measured with reference to a standard initial load or load reduction, it simply represents a certain multiple of D value. For example, if TDT represents the time to reduce the population from 10^0 to 10^{-12}, then TDT is a measure of 12 D values. i.e., TDT = nD, where n is the number of decimal reductions. The extent of inactivation in the case of pathogenic microorganisms (*C. botulinum*) is equivalent to a 12 D process. The slope of the TDT curve is defined as 'z' value, which is the number of degrees for the TDT curve to traverse one log cycle. The temperature sensitivity indicator is defined as z, a value which represents a temperature range which results in a ten-fold change in D values or, on a semilog graph, it represents the temperature range between which the D value curve passes through one logarithmic cycle. The 'z' value which is also known as the temperature sensitivity indicator is usually taken as 10°C in the case of *C.botulinum.*

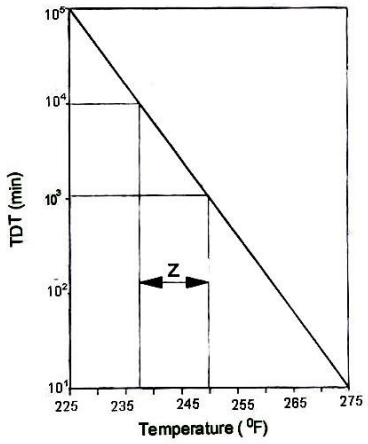


Fig. 2 TDT Curve

For the purpose of heat process determination with respect to their lethality towards specific micro-organisms, the reciprocal of the thermal death time (TDT value) called the lethal rate, L is used. So, instead of temperatures, the corresponding lethal rates are plotted against time, the area enclosed by the graph and the ordinate represent the F value for the process. i.e.,

$$L = \frac{1}{TDT}, \quad \text{and}$$

t

$$F = \int_0 L\, dt$$

Thermal Process Severity or F_0 value

From D value and the initial number of spores inside the sealed container (N_o), an idea of the severity of heat process required to reduce the spore population to a predetermined level, N_t, can be calculated from the equation:

$t = D (\log No - \log N_t)$ or $t = D \log (No/N_t)$

where, t = time required to achieve commercial sterility

This $\log No/N_t$ is sometimes referred to as the 'order of process', factor 'm' and the value of the product of m and D is called the 'process value' or 'F value'. That is:

$$F_0 = mD_{121.1°C}$$

For example, considering the generally accepted minimum process for prevention of botulism through under processing of canned fishery products preserved by heat alone, assuming that the initial loads are of the order of 1 spore/g and in line with good manufacturing practice guidelines, the final loads shall be no more than $\log 10^{-12}$ spores/g. That is 12 decimal reductions are required. It is also known as 12 D process. The minimum time required to achieve commercial sterility can be calculated from

$$t = 0.25 (\log 1 - \log 10^{-12}),$$

i.e., $t = 0.25 \times 12 = 3.00$ min

Thus an F_0 value of 3.00 minutes at 121.1°C at the slowest heating point (SHP) of the container is sufficient for providing safety from pathogenic organism *C. botulinum*.

Commercial sterility

If the thermal process is sufficient to fulfill the criteria of safety and prevention of non-pathogenic spoilage under normal conditions of transport and storage, the product is said to be 'commercially sterile'. In relation to canned foods, the FAO/WHO Codex Alimentarius Commission (1983) defines, commercial sterility as the condition achieved by the application of heat, sufficient alone or in combination with other appropriate treatments, to render the food free from microorganisms capable of growing in the food at normal non-refrigerated conditions at which the food is likely to be held during distribution and storage. Apart from this concept there are circumstances where a canner will select a process which is more severe than that required for commercial sterility as in the case of mackerel and sardine where bone softening is considered desirable.

Mechanism of heat transfer

Understanding the mechanism of heat transfer is very important for thermal processing. Normally, there are three different modes of heat transfer: conduction, convection and radiation. Conduction is the transfer of heat by molecular motion in solid bodies. Convection is the transfer of heat by fluid flow, created by density differences and buoyancy effects, in fluid products.

Radiation is the transfer of electromagnetic energy between two bodies at different temperatures. In thermal processed foods, the mechanism of heat transfer is either by conduction, convection or by broken heating (combination of conduction and convection). The factors which determine the mode of heat transfer are nature or consistency of a food product, the presence of particles, and the use of thickening agents and sugars. The heating modes in the thermal processing are first by heat transfer to the container or packaging material from heating and cooling media, second through the container wall and third is into the product from container wall. Convective-heat transfer rates depend largely on the velocity of flow of the media over the container, and this is an important factor to be controlled in all processing operations. In conduction heading method, energy transfer takes place when different parts of a solid body are at different temperatures. The slowest heating point or cold point in cylindrical metal containers is at its geometric centre for food products heated by conduction method. Convection heat transfer involves the transfer of heat from one location to the other through the actual movement or flow of a fluid. The slowest heating point for convection heated products in cylindrical metal container is approximately $1/10^{th}$ up from the base of the container. Packaging material forms the most important component of thermal processed foods. It should be able to withstand the severe process conditions and should prevent recontamination of the product.

Containers for thermal processing

Containers used for thermal processing should have special properties like it should withstand high temperature and pressure. Tin cans are commonly used in the canning industry and cans are denoted by trade name. First digit represents diameter of can (in inches) and next two digits represent measurement in sixteenth of inches. Apart from OTS cans, other container used in canning are: aluminium cans, tin free steel (TFS) cans, glass containers, retort pouches and semi-rigid containers.

Table 1. Cans used in fish canning industry

Trade Name	Dimension	Over-seam dimension
41/2 OZ prawn cans	301 x 203	77 x 56
8 oz prawn cans	301 x 206	77 x 60
1 lb. jam can	301 x 309	77 x 90
No.1 tall can	301 x 409	77 x 116
8 oz. tuna can	307 x 113	87 x 43

Nowadays, retort pouch processing is very popular. The retort pouches are flexible in nature and they easily withstand high temperatures used during thermal processing. They also

provide good barrier against moisture and gases. The most common retort pouch is 3 layered laminate. The 3 layers are joined with adhesive lamination. These three layers are:

- Polyester layer which helps in providing strength and abrasion resistance
- Aluminium foil for providing barrier against moisture, gases and light
- Polypropylene/ polyethylene for heat sealing properties.

Composition of Retortable pouch

Ideally, the container used for thermal processing should fulfill following characterisitcs:

- Should withstand the sterilisation pressure and temperature
- Should be impervious to air, moisture, dust and disease germs once the can is sealed air tight
- Internal lacquer should not impart toxicity to the contents
- Strong enough to protect the contents during transportation and handling
- Inexpensive, preferably cheap enough to discard after use
- Capable of sealing at high speed
- Pleasing and sanitary appearance

Thermal Processing of Fishery Products

The thermal processing is carried out for achieving two objectives; the first is consumer safety from botulism and the second is non-pathogenic spoilage which is deemed commercially acceptable to a certain extent. If heat processing is inadequate the possibility of spoilage due to C. *botulinum* is more and will endanger the health of the consumer. Safety from botulism is made possible by making the probability of *C. botulinum* spores surviving the heat process sufficiently remote and presents no significant health risk to the consumer. An acceptable low level in the context of this dangerously pathogenic organism means less than one in a billion (10^{-12}) chance of survival. Such a low probability of spore survival is commercially acceptable as it does not represent a significant health risk. The excellent safety record of the canning industry with respect to the incidence of botulism through under processing, confirms the validity of this judgment. An acceptable low level in the case of thermophilic non-pathogenic organisms should be arrived at judiciously considering the factors like very high D value, risk of flat sour spoilage, commercial viability and profitability etc. Since non-pathogenic organisms do not endanger the health of the consumer process adequacy is generally assessed in terms of the probability of spore survival which is judged commercially acceptable. Considering all these facts, it is generally found acceptable if thermophilic spore levels are reduced to around 10^{-2} to 10^{-3} per g. Another reason for this acceptance is that the survivors will not germinate if the storage temperature is kept below the thermophilic optimum growth temperature i.e. below 35°C.

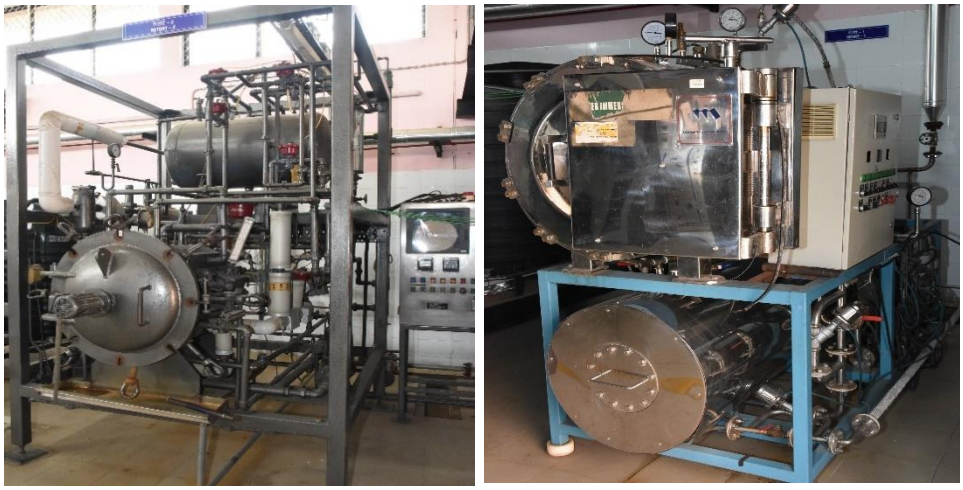
Fishery products, being categorized as low acid foods require heat processing severity with respect to *C botulinum* and F_0 value recommended is 5-20 min. Thermal processing of fishery products include various steps. These steps include, preparations like washing, beheading, gutting, removing scales / fins, cutting into required size, blanching (hot / cold), pre-cooking, filling fish pieces into containers, filling content or medium, exhausting to remove air, sealing, loading into the retort or autoclave, sterilization, washing and storing. Various packaging materials have been used from historically starting from glass container to metal container, flexible retortable pouches and rigid plastic containers. The sterilization process in the canned product can be subdivided into three phases. First one is heating phase, in which the product temperature is increased from ambient to the required sterilization temperature by means of a heating medium (water or steam). This temperature is maintained for a defined time (phase 2 = holding phasing). In (phase 3 = cooling phase) the temperature in the container is decreased by introduction of cold water into the autoclave. In order to reach temperatures above 100°C (sterilization), the thermal treatment has to be performed under pressure in pressure cookers, also called autoclaves or retorts. Simple autoclaves are generally vertical ones with the lid on top. Through the opened lid, the goods to be sterilized are loaded into the autoclave. The cans are normally placed in metal baskets. The autoclave and lid are designed to withstand higher pressures up to 5.0 bar. These types of autoclaves are best suited for smaller operations as they

do not require complicated supply lines and should be available at affordable prices. Larger autoclaves are usually horizontal and loaded through a front lid. Horizontal autoclaves can be built as single or double vessel system. The double vessel systems have the advantage that the water is heated up in the upper vessel to the sterilization temperature and released into the lower (processing) vessel, when it is loaded and hermetically closed. Using the two–vessel system, the heat treatment can begin immediately without lengthy heating up of the processing vessel and the hot water can be recycled afterwards for immediate use in the following sterilization cycle. In rotary autoclaves, the basket containing the cans rotates during sterilization which enhances the heat penetration resulting in reduced process time. This technique is useful for cans with liquid or semi-liquid content as it achieves a mixing effect of the liquid/semi-liquid goods. Water immersion retorts are also used in the industry for thermal processing which is advantageous over steam retorts due to its uniform temperature distribution as there is no possibility of forming air pockets in the retort which limits the heat transfer in steam retorts. At the final stage of the sterilization process the products must be cooled as quickly as possible by introducing cold water. The contact of cold water with steam causes the latter to condense with a rapid pressure drop in the retort. However, the overpressure built up during thermal treatment within the cans, jars or pouches remain for a certain period. During this phase, when the outside pressure is low but the pressure inside the containers is still high due to high temperatures there, the pressure difference may induce permanent deformation of the containers. Therefore, high pressure difference between the autoclave and the thermal pressure in the containers must be avoided. This is generally achieved by a blast of compressed air into the autoclave at the initial phase of the cooling. Sufficient hydrostatic pressure of the introduced cooling water can also build up counter pressure so that in specific cases, in particular where strong resistant metallic cans are used, the water pressure can be sufficient and compressed air may not be needed unlike in flexible retortable pouches. After thermal processing, the containers are washed with chlorinated potable water and stored for conditioning for 2 – 4 weeks. Conditioning helps in proper mixing of the ingredients with the fish products and helps in assessing the extent of thermal process severity. If the containers do not show any deformation, it indicates the effectiveness of the thermal processing.

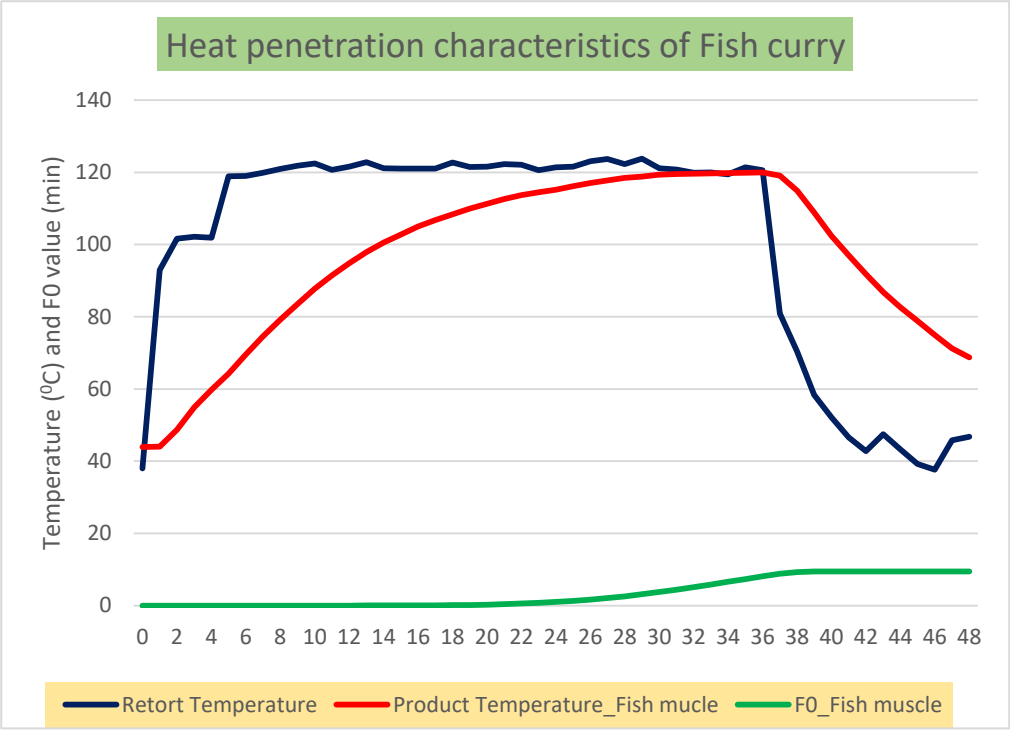
The important steps in canning process are:

1. Raw material preparation
2. Blanching/ Precooking
3. Filling into containers
4. Addition of fill (brine/ oil/ gravy)
5. Exhausting
6. Seaming/ sealing
7. Retorting (heat processing)
8. Cooling

9. Drying
10. Labelling and storage



Steam retort and water immersion retort



Typical heat penetration curve of fish curry in retortable pouches

Chitins: An overview

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Chitin is a relatively recent term used to collectively refer 'chitin and its derivatives' such as chitosan and chitosan oligomers. Chitin is a nitrogenous polysaccharide (poly N-acetyl Amino D- glucose) found in the exoskeleton of insects, shrimps, crabs, lobsters and internal structure of other invertebrates. It is the most abundant organic compound next to cellulose on the earth. Antarctic krill and squid skeleton are typically rich in chitin (~ 40%), while the dry shells of lobster, crab, cray fish, and prawns generally contain around 14-35% chitin. It is also an important structural component of the cell wall of some plant-pathogenic fungi, especially Zygomycets. The average annual global production of chitin by arthropods has been estimated to be around 13,28,000,000 MT from marine ecosystem, 28,000,000 MT from freshwater ecosystem, and 6,000,000 MT from athalassohaline ecosystem. According to Food and Agriculture Organisation (FAO), a considerable amount of crustacean shell is discarded as processing waste, which means the raw material for production of this biologically active molecule is readily available at low cost (Barrow and Shahidi, 2007).Chitin is described as a colorless, crystalline or amorphous powder, which is insoluble in water, organic solvents and diluted acid and alkali. Chitin is present as chitin-protein complex along with minerals, mainly in the form of calcium carbonate. So the process of chitin production consists of deproteinisation with dilute alkali and demineralization with dilute acids. Chitin on deacetylation gives chitosan and on hydrolysis with concentrated HCl gives glucosamine hydrochloride. Chitin and chitosan are natural, nontoxic, biodegradable compounds with a broad range of commercial applications. Chitosan is a large, polycationic polymer having degrees of acetylation ranging from 5 to 30%. Depolymerisation of chitosan by chemical and enzymatic hydrolysis yields water-soluble chitosan oligomers or chito-oligomers. Generally, chitosan with molecular weight <39 kDa and degree of polymerization <20 are known as chitosan oligomers or chito-oligomers (Mourya et al., 2011)

Chitosan

Chitosan and its derivatives have been researched extensively for biomedical applications and unique biological effects such as antioxidant, anti-allergic, anti-inflammatory, anticoagulant, anti-cancer, anti-bacterial, anti-human immuno deficiency virus, anti-hypertensive, anti-Alzheimer's, anti-diabetic, anti-obesity and matrix metalloproteinases inhibitory activities. Among these, the most extensively covered property in literature is antimicrobial property. Mainly, two different mechanisms are proposed as the cause behind the antimicrobial activity of chitosan; first one, being polycationic in nature, chitosan interferes with bacterial metabolism by electrostatic stacking at the cell surface of bacteria; the other is by way of blocking the transcription of RNA from DNA by adsorption of penetrated chitosan on DNA molecules.

However, for the latter one, the molecular weight of chitosan must be small enough (~5000 Da) to be able to permeate into cell.

Structurally, chitosan has three types of reactive functional groups, namely, an amino/acetamido group as well as both primary and secondary hydroxyl groups at the C-2, C-3 and C-6 positions, respectively. The degree of acetylation and/or deacetylation of amino functionality are the main factors which contribute to the differences in chitosan structures and physico-chemical properties. Other important characteristicsof chitosan aremolecular weight, chain length and its distribution. The molecular weight of commercial chitosan ranges from 1,00,000 to 10,00,000 Da. Mild hydrolysis of chitosan yields antibacterial oligomers; however, extensive hydrolysis of chitosan may result in reduced antimicrobial activity (Varun et al., 2017).Chitosan oligomeres with five to seven D-glucosamine units are reported to have good bioactivity. By modulating and improving these structural characteristics, chitosan and its derivatives may find potential in novel applications including the prevention or treatment of chronic diseases.

Chitin and chitosan, have attracted a great attention of researchers around the world in the past few decades due to their broad range of nutraceutical and healthcare benefits. Currently, chitosan is regarded as a potential marine nutraceutical owing to its superior biological activities, biocompatibility and non-toxic nature. It is the most popular natural food additive used as a preservative in a wide array of products, including snacks and beverages. In the food industry, the hydrolysis of chitosan is aimed to decrease its bitter and astringent-taste and to increase solubility of chitosan at neutral pH. The chitosan hydrolysates exhibiting molecular weights between 30 and 41 kDa were considered to be most suitable as a food additive or functional agent as demonstrated by sensory evaluation.

Chitosan is a popular dietary fibre often used to treat obesity and high cholesterol level (Schiller et al., 2001; Sumiyoshi et al., 2006; Trivedi et al., 2016). There are a number of *in vitro* and *in vivo* reports demonstrating the dietary lipid and bile acid binding activities of chitosan (Zhang et al., 2015).The cationic nature of chitosan enables it to bind to the negatively charged lipids, thereby reducing their gastrointestinal uptake and serum cholesterol level. Chitosan absorb many times their weight of fat and cholesterol. A very recent report on the clinical investigation of chitosan supplementation for 8 weeks indicatedlower blood lipid level, simultaneously maintaining the normal calcium, magnesium, and iron statusin elderly hyperlipidemic patients.Apart from that chitosan is reported as effective against the complications that kidney failure patients on dialysis often face, including high cholesterol, anemia, loss of strength and appetite, and disturbed sleeping (insomnia). Choi et al. (2012) have demonstrated the effect of chitosan oligomers on body weight gain, adipocyte size, adipokine level, lipid profile, and adipose tissue gene expression profile in high-fat diet-induced obese mice. Mice fed with high fat diet supplemented with 3% chitosan oligomers had gained 15% less weight but did

not display any change in food and energy intake. Apart from that, chitosan supplementation markedly improved the serum and hepatic lipid profiles.Chitosan has been used as an antioxidant for protection of oils and fats against oxidation. It was reported that chitosan at concentration of 0.02% (w/v) had antioxidant activities in lard and crude rapeseed oil. However the activity was less than ascorbic acid. Investigations by Xie et al., (2001) have demonstrated that the scavenging mechanism of chitosan is related to the fact that the free radicals can react with the hydrogen ion from the ammonium ions to form a stable molecule. Chitosan could also significantly reduce serum free fatty acid and malondialdehyde concentrations and increase antioxidant enzyme activities such as superoxide dismutase, catalase and glutathione peroxidase, indicating antioxidant enzyme regulating activities and decreased lipid peroxidation. However, the mechanism of antioxidant activity of chitosan is still disputable. Many studies have clearly shown low or no antioxidant activity of native chitosan, although the activity significantly increased with appropriate chemical modifications of the biopolymer. Studies by Je et al., (2004) have shown that chitosan may eliminate various free radicals by the action of nitrogen on the C-2 position of the chitosan. Further, the effects of dietary chitosan supplementation on lipid peroxidation and cardiac antioxidant defence system in isoprenaline-induced myocardial infarction in rats was reported (Anandan et al., 2012). Similarly, anti-aging effect of dietary chitosan supplementation on glutathione-dependent antioxidant system in young and aged rats was demonstrated (Anadan et al., 2013).

The anti-inflammatory activity of chitosan and chitosan oligomers is well documented in literature (Azuma et al., 2015). Fernandes et al. (2010) have demonstrated that the anti-inflammatory activity of chitosan oligomers in carrageenan-induced paw oedema method was not only dose-dependent but also molecular weight-dependent at higher doses. Apart from that oral administration of chitosan oligomers was found to be effective against intestinal inflammation and mortality in mouse model of acute colitis.

Chemically modified biofunctional chitosan derivatives is a new addition to the industry, and may open up new applications in functional food and nutraceutical development. Two new conjugates, namely vanillic acid and coumaric acid grafted chitosan derivatives with superior antioxidant and antimicrobial activities compared to native chitosan was developed by Chatterjee et al. (2016). Besides, chitosan has been successfully used in controlled or targeted delivery systems of nutrients and bioactive compounds. Chitosan has several advantages in encapsulation over other biopolymers, namely; ability to adhere to the gastric mucosa, lack of allergic or irritant reaction, pH dependent controlled release of the encapsulated bioactive material etc. It has been successfully used for encapsulation of cashew apple extract, olive leaf extract, tuna oil, enzymes, lactose and various antioxidants.The mounting research data published in this area every year evidently indicate the growing interest in application of chitosan and chitosan derivatives in health and nutrition.

Glucosamine

Glucosamine (2-amino-2-deoxy-D-glucose) is an amino-monosaccharide derived by the hydrolysis of chitin. Glucosmaine is primarily a component of articular cartilage, intervertebral disc and synovial fluid. Glucosamine is chemically glucose in which a hydroxyl group on the second carbon atom is substituted with an amino group. It crystalizes as glucosamine hydrochloride during purification under acidic conditions. Among the various derivatives, glucosamine hydrochloride and sulfate are the most commercialized forms worldwide. Glucosamine, is classified as a 'safe dietary supplement' and is widely marketed for pain relief in osteoarthritis.

With age, the body's ability to produce glucosamine may become impaired, resulting in considerable dysfunction and pain. As a "building block" of cartilage, glucosamine appears to have the ability to treat osteoarthritis by protecting and strengthening cartilage, allowing it to retain its cushioning effects and lubricate the joints. It also plays a role in preventing further joint damage, helps to reduce inflammation and supports pain-free movement of the joints by enhancing cartilage synthesis and inhibiting cartilage break down.

There is now a large convergent documental evidence that glucosamine sulfate, given at a daily oral dose of 1,500 mg, is able to significantly reduce the symptoms of osteoarthritis (Reginster et al., 2012). It is one of the amino sugars used by biological systems for bringing modification to the functions of proteins. Although glucosamine was discovered long back, the interest in nutraceutical use received great attention since last two decades. The rationale in using glucosamine for arthritis is that in the joint and synovial fluid glucosamine will stimulate the synthesis of proteoglycans that help in repair of damaged cartilage, such as hyaluronic acid, heparin sulphate, and keratan sulphate. In the cartilage system, proteoglycans are intertwined with collagen network. Due to the net negative charge of the proteoglycans, a large amount of water is enclosed in the cartilage mass. This water content is important for the resilient and elastic properties of collagen fibrils as well as for the lubrication of the joint system. Also, as a "building block" of cartilage, glucosamine appears to have an ability to treat osteoarthritis by protecting and strengthening cartilage, allowing it to retain its cushioning effects and lubricate the joints. It also plays a role in preventing further joint damage, helps to reduce inflammation and supports pain-free movement of the joints by enhancing cartilage synthesis and inhibiting cartilage break down.

Glucosamine has been designated as an 'over the counter' dietary supplement by the US Food and Drug Administration. Although there are contradictory reports on the effectiveness of glucosamine in the treatment of osteoarthritis, there are more than 150 generic preparations of glucosamine alone or in combination with similar supplements in the global market. Taniguchi et al. (2012) reported that long-term oral administration of glucosamine sulfate reduced the

destruction of cartilage and upregulation of MMP-3 mRNA in a model of spontaneous osteoarthritis in Harley guinea pigs. Oral administration of glucosamine sulfate for at least 12 months may prevent the need for knee arthroplasty, revealing the profound extent of the disease-modifying power of this compound. Collagen peptide is also reported to have synergistic effects with glucosamine. Inspite of all promisive results, the use of glucosamine in the management of osteoarthritis remains controversial and its specific mechanism of action in pain relief and function modification are still unclear. Animal experiments have shown that, glucosamine is having good peptic ulcer healing properties. Oral administration of glucosamine helps in the synthesis of gastric mucosa to repair the ulcer and provides pain relief. Latest research has claimed that glucosamine supplementation mimics low calorie diet in rats and increased the life span compared to control animals. Calorie restriction was proven in animals to improve the life span in laboratory studies. Gliucosamie was shown to reduce the amount of glucose metabolized through the glycolytic pathway thus mimics low calorie diet.

Glucosamine is a more recent entry to the nutracosmetic category. It can increase the skin's content of hyaluronic acid to increase moisturization, leading to enhanced skin barrier properties and reduced dryness. Glucosamine has also been reported to have potential to inhibit skin melanin production. Glucosamine has been shown to inhibit glycosylation, the addition of polysaccharide units to proteins in *in-vitro* melanocyte cell culture. Glycosylation is a required step in the conversion of certain inactive pro-enzymes to their active forms. Active tyrosinase, a key enzyme in the pathway for melanin production, is glycosylated. Thus, glucosamine inhibits the production of melanin in melanocytes.

Apart from the well-known antiarthritic and antiaging potential, recent evidences suggest a potential beneficial effect of glucosamine against cancerrisk. In these studies, the anti-cancer activity was more correlated with either one of, a decreased DNA synthesis, cell cycle arrest in G1 phase, induction of apoptosis, or inhibition of protein N-glycosylation. Based on a few other observations, glucosamine has been found to be useful for ameliorating inflammamtory bowel disease, migraine, and viral infections. In addition to that, there have been a number of studies suggesting the anti-inflammatory, antioxidant, antifibrotic, neuroprotective and cardioprotective activities of this aminosugar, enlisting it as an ideal neutrceutical supplement for meeting many of the dietary requirements.

Glucosamine is a natural component of the human body, hence, more compatible and does not impose any side effects. Glucosamine is normally synthesised in our body from its precursors however, in instants of osteoarthritis, glucosamine supplementation may be beneficial. An observed safety level (OSL) of up to 2000 mg/day reported for glucosamine, supports a confident conclusion of their long-term safety.Hence, it may be wiser option to consider the use of glucosamine as a combination therapy with other dietary supplements for better and promisive

results. It is available commercially in different forms in market, including in combination with herbs, vitamins, creatine, chondroitin sulphate, ascorbic acid, manganese or dimethylsulfone. Of the various available forms of commercially available glucosamine, glucosamine sulfate is found to be more effective for treating osteoarthritis.

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Utilization of secondary raw material from fish processing industry

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Introduction

Fish and shellfish constitute an important component of global nutrition. Fish protein is an essential source of nutrients for many people, especially in developing countries. Health benefits of fish oil in preventing heart attack and other cardiovascular diseases are well appreciated. Mounting evidences suggest that the benefits of fish consumption are not limited to the well-known effects of fish oil alone. Fish is also a rich source of protein containing all essential amino acids, which is required for the body maintenance and muscular build-up. The protein content of most of the raw finfish meat is in the range of 17 to 22% (g per 100 g), while the cooked portions of some fish such as tuna may have as high as 30% protein. The amino acid score of fish protein compares well with that of whole egg protein, which is considered as a standard protein source. Fish is also rich in the non-protein amino acid - taurine, which has a unique role in neurotransmission. Apart from nutritional properties, fish proteins also possess a number of functional properties such as emulsifying, foaming, gel forming, water binding and fat binding properties, which are important in product formulations. These functional properties are mainly attributed to the major myofibrillar proteins, actin and myosin.

During the processing of fish generally only the fillets are retained while the bulk of product (up to 66%) is discarded. About 30% of the total fish weight remains as waste in the form of skins and bones during preparation of fish fillets. This waste is an excellent raw material for the preparation of high value products including protein foods. The utilization of fish wastes help to eliminate harmful environmental aspects and improve quality in fish processing. Skin and bone are sources of high collagen content. The average quantity of waste generated during fish and shellfish processing operations (based on average annual marine landing data) is indicated in Table 1.

Table 1: Waste generation in industrial fish processing in India

Products	Waste generated (%)
Shrimp products (PD, PUD, HL, etc.)	50
Fish fillets	70
Fish steaks	30
Whole and gutted fish	10
Cuttlefish rings	50
Cuttlefish whole	30
Cuttlefish fillets	50
Squid whole cleaned	20
Squid tubes	50

Squid rings	55

Source: Anon (2005)

At present, India is the second largest producer of fish in the world with second position in aquaculture production as well as in inland capture fisheries. The total fish production during 2013-14 (provisional) is registered at 9.58 mMT, with a contribution of 6.14 mMT from inland sector and 3.44 mMT from marine sector (Hand book on fisheries statistics, 2014). This indicates, a minimum of 4MT of fishery waste has been generated every year, even though it is scattered in the domestic and industrial sector.

An important waste reduction strategy for the industry is the recovery of marketable byproducts from fish wastes. Hydrolyzed fish wastes can be used for fish or pig meal as well as fertilizer components. The three most common methods for utilization of aquatic waste (either from aquaculture or wild stock) are the manufacture of fishmeal /oil, the production of silage and the use of waste in the manufacture of organic fertilizer . The utilization of by-products is an important cleaner production opportunity for the industry, as it can potentially generate additional revenue as well as reduce disposal costs for these materials. The transportation of fish residues and offal without the use of water is an important factor for the effective collection and utilization of these by-products. Some viable options for generating wealth from waste are detailed below.

Fish meal: Fish meal is highly concentrated nutritious feed supplement consisting of high quality protein, minerals, vitamins of B group and other vitamins and other unknown growth factors. Fishmeal is rich in essential amino acids. It is produced by cooking, pressing, drying and grinding the fish, by-catch fish, and miscellaneous fish. Fishmeal production also provides a major outlet to recycle trimmings from the food fish processing sector, which might otherwise be dumped at extra cost to the environment and the consumer. Spain, France, Germany, Ireland and the UK produce fishmeal primarily from trimmings. The composition of fishmeal differs considerably due to the variations in the raw material used and the processing methods and conditions. In India, oil sardine (*Sardinella longiceps*) is extensively used for the production of fish meal and oil. Most of the pelagic fishes mentioned earlier are rich in body oil. Hence both fish meal and fish body oil are produced in the same industry. Freshness of fish is very important in getting good quality fish meal. If the fish has lost its freshness, it will have high TVBN content and consequently, the meal produced from it will also contain high TVBN which is unacceptable to shrimp feed industry. In addition to oil sardines, fish dressing waste or cutting wastes (head and viscera) of surimi industry are also used in fish meal manufacture in India. In this case also, the quality parameters regarding freshness of waste have to be maintained. Generally, fish meal produced from fish processing waste, contain low percentage of proteins and high proportion of ash/minerals. Hence, it is not possible to produce Grade I fish meal using only wastes from fish processing industry.

The main objective in the production of fish meal is to reduce the moisture content of fresh fish (70-80%) to about less than 10% in the meal. Oil content in the fish meal should not be more than 10%. Hence, 80 to 90% of oil present in fish has to be removed during fish meal production. The most common methods employed for the manufacture of fish meal are dry rendering and dry rendering process. Dry rendering or dry reduction process is suitable for only lean or non-oil fish such as silver bellies, jew fish, sciaenids, ribbon fish, sole, anchoviella, carcasses of shark, fish offal and filleting waste. In this process, it is dried to moisture content of 10% and pulverized. If the quantity to be handled is sufficiently large a steam jacketed cooker dryer equipped with power devises for stirring is used. Being batch operation the process will have only limited capacity and labour cost is very high. Merit of this process is that the water-soluble materials are retained in the meal. Wet rendering or wet reduction process is normally applied to fatty fish or offal where simultaneous production of fish meal and fish body oil is envisaged. The process consists of grinding, cooking to soften the flesh and bones and to release the oil, pressing to expel the liquor and oil, fluffing the press cake drying, grinding and packing the meal, The press liquor is centrifuged to remove the suspended particles and to separate oil. The stick water is concentrated to retain protein and other valuable components. The press cake is fluffed and dried to a moisture level of 8%.

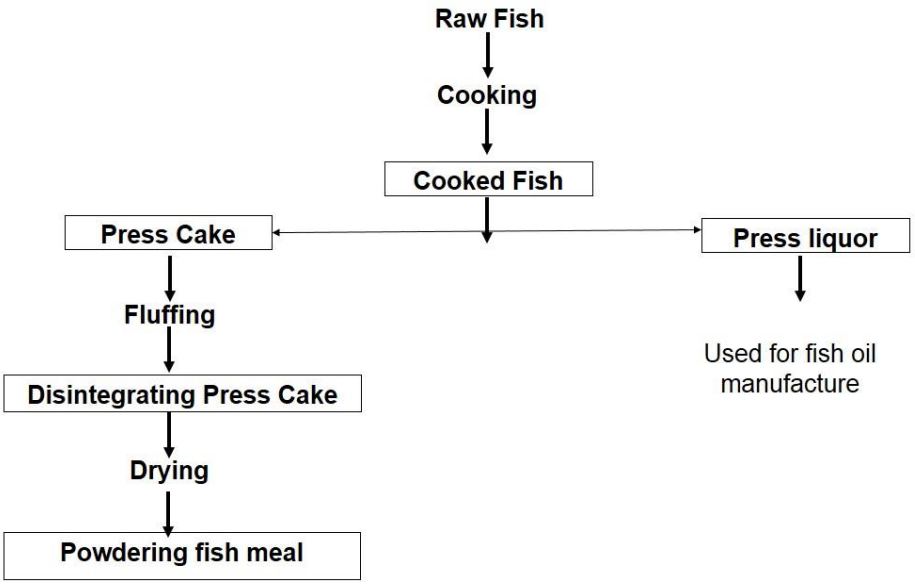

Figure 1. Wet Reduction Method for Fish Meal and Oil Manufacture

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Drying is one of the key processes in fish meal production. The dryer used can affect many of the important attributes of fish meal quality. Raw material freshness is important if a producer wants to make premium quality fish meal. Enzymatic and bacteriologic activity in the

fish can rapidly decrease the content and quality of the protein and oil. Protein decomposes into amines and ammonia, and both reduce the protein value and recovery of protein. The raw material freshness and drying methods are determining factors of fish meal quality.

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 (Mathew, 2014). 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, Asean seabass etc. implies that there is a good scope for flourishing finfish and shellfish production through aquaculture in near future. This inturn 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 replacer and food flavouring. Enzymes like papain, ficin, trypsin, bromelein and pancreatin are used for hydrolysis. The process consists of chopping, mincing, cooking and cooling to the desired temperature, hydrolysis, sieving, pasteurizing the liquid, concentrating and drying (by vacuum or spray drying). The fish protein hydrolysate have desirable functional properties with potential applications as emulsifiers and binder agents. It can also be used in place of diary based and plant based protein hydrolysates (Binsi et al., 2016). 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 possess superior 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 possess good 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. Gelatin is the partially hydrolysed form of collagen. 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-Central Institute of Fisheries Technology (Cochin, India) has standardised a protocol for the extraction of collagen peptide from fish scale and bone. Further a nutritional mix based on collagen peptides was developed with 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.

Collagen peptide from fish scale and Nutritional mix formulated by CIFT

Surgical sutures from fresh water fish gut

Absorbable fine grade sutures are essential for microsurgeries and ophthalmic surgeries. CIFT has developed the method for the preparation of absorbable surgical sutures from fish gut. The production of sutures involves a low cost technology. Fish gut is separated and washed thoroughly to remove impurities and soluble proteins. The collagen fibres separated are twisted, cross-linked and bodied to give fine threads of collages. They are surface smoothened, cut to size and packed in isoporpanol. The packed sutures are sterilized to give absorbable surgical sutures. The sutures developed by this method are evaluated for tenacity, absorbability, freedom from abnormal tissue reaction etc.

Fish ensilage and foliar spray: When the animal farms are very near to 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. Fish silage is preserved against microbial spoilage mainly by the lowered pH,

obtained by the added or in-situ produced acid. Specifically, the unionized acid molecules are able to cross the cytoplasmic membrane barrier of the microbial cell while protons (H+) and acid anions cannot. But once inside the cell, the acid mole can ionize and since the membrane traps the ions, the pH gradually comes down killing the cell. Thus it is the unionized acid molecules that are responsible for the preservative action rather than the total acid concentration. At equal concentrations, organic acids are weakly ionized in solution when compared to inorganic acids, thus contain greater amount of unionized (free acid) molecule making them more effective preservatives. In case of fermented silage, preservation occurs by several means. The presence of fermentable sugar is the beginning of the ensilation process prevents immediate deamination of amino acids by bacteria that would lead to ammonia production and foul smell. Later as the fermentation by lactic acid bacteria becomes dominant, spoilage bacteria are suppressed or killed by the increasing concentration of lactic acid, lowered pH and the production of several antibiotic substances called bacteriocins by the lactic acid bacteria. 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.

Enzymes: There is a great demand for enzymes with right combination of properties for a number of industrial applications. Enzymes from marine fisheries resources have wide biotechnological potential as they have some unique properties for industrial applications, e.g. in the detergent, food, pharmaceutical, leather and silk industries. Among the enzymes derived from various sources, marine enzymes have certain technological advantages. Some of the distinctive features of enzymes derived from fish include, the higher catalytic efficiency at lower reaction temperatures, and stability at wide range of pH and in the presence of surfactants or oxidizing agents. The higher catalytic activity at lower temperature is a unique property that further permits to process foods at low temperatures such as fruit juices, thereby protects heat-labile food components and reduces the energy cost. Similarly, the lower thermo-stability of marine enzymes would permit their complete inactivation by mild heat treatments, whereas the enzymes from microbial and plant resources often requires heating at above 90^{o}C for a minimum duration of 10 min for stopping the enzymatic reaction. World-wide the sales of industrial

enzymes are growing at a fat rate. Presently, industrial enzymes are mostly derived from microorganisms and to a lesser extent from plant and bovine sources. Sofar, there is only very limited use of marine derived enzymes by industry. The reason may be the limited basic informations on these enzymes, the seasonal nature of raw material availability, the psychological inertia of the public towards fish offal, and to a greater extent, due to the lack of proper techniques for the recovery of enzymes from fish processing waste which comprises of a complex mixture of various biomolecules such as proteins, lipids, minerals, glyco-proteins etc. It is suggested that future research may be focused on the development efficient and cost-effective technologies for the recovery of various enzymes from fishery resources, so that some of the unique properties of marine enzymes may be exploited in various food applications, and thereby, obtain a share of lucrative industrial enzyme market to increase the profit for fish processing industry.

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. 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. 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 from 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 CIFT in albino rats have shown that fish calcium powder supplemented with vitamin D has improved the absorption and bioavailability.

Chondroitin Sulphate: Chondroitin sulfate (CS) is a major component of the extracellular matrix (ECM) of many connective tissues, including cartilage, bone, skin, ligaments and tendons. It is formed by repeating disaccharide units of glucuronic acid (GlcA) and N-acetylgalactosamine (GalNAc). The skeleton of shark and ray is therefore an attractive source of CS. This polymer is at the moment object of increasing attention in the engineering of biological tissues, especially in connection with the repair of bone, cartilaginous and cutaneous wounds. It

is part of a large protein molecule (proteoglycan) that gives cartilage elasticity. Chondroitin sulphate is been used for the treatment of arthritis. Its high content in the aggrecan plays a major role in allowing cartilage to resist pressure stresses during various loading conditions. Chondroitin sulfatation profile has been described in cartilage CS is sold as over the counter dietary supplement in North America and is a prescription drug under the regulation of the European Medicine Agency (EMEA) in Europe. The extraction of CS includes the following steps: cartilage hydrolysis (with strong alkalis or using proteases), ethanolic precipitation of the hydrolysates and treatment of the redissolved precipitate (with ionic exchange resins or by means of dialysis) in order to eliminate remaining peptides and salts (Sumi et al., 2002).

Squalene: Squalene is a natural dehydrotriterpenic hydrocarbon ($C_{30}H_{50}$) with six double bonds, known as an intermediate in the biosynthesis of phytosterol or cholesterol in plants or animals. It is present in the liver oil of certain species of deep sea sharks mainly Centrophorus and Squalidae spp. In the case of deep-sea sharks, the liver is the main organ for lipids' storage, being in the same time an energy source and means for adjusting the buoyancy. 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.In their case, the unsaponifiable matter represents 50–80% of the liver, the great majority thereof being squalene. Squalene has a melting point lower enough to allow the cooling composition to remain liquid, even at temperatures between −10°C and −60°C, unlike the ordinary oily topical drugs. Squalene is used as a bactericide, an intermediate in the manufacture of pharmaceuticals, organic colouring matter, rubber, chemicals, aromatics, in finishing natural and artificial silk and surface active agents. Nowadays it is extensively used as an additive in pharmaceutical preparations, cosmetics and health foods. 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. Squalene was also used as an adjuvant in vaccines, stimulating the immune response and increasing the patient's response to vaccine. It is added to lipid emulsions as drug carrier in vaccine applications. Squlalene helps in regulating the female menstrual cycle and also improves irregular and abnormal cycles. Shark liver oil remains the richest natural source of squalene, eventhough it is widespread in animal and vegetal kingdom. ICAR-CIFT has standardised the protocol for extracting squalene from shark liver oil.

Hydroxyapatite (HAp): Hydroxyapatite is the major mineral component of bone tissue and teeth, with the chemical formula of $Ca_{10}(PO4)_6(OH)_2$. The composition Hap derives from biological sources differs from that of synthetic hydroxyapatite, due to the presence of several ionic substitutions in the lattice, such as CO_3, F, Mg^{2+} and Na^{+}. It is a member of the calcium phosphate group with 1.67 stoichiometric of Ca/P ratio. It is one of the few materials, classified as a bioactive biomaterial that supports bone in growth and osseointegration when used in orthopedic, dental and maxillofacial applications. Fish bone and scale is a rich source of

hydroxyapatite. The hydroxyapatite content of fish skeleton may vary between 40-60%. Generally, very high heat treatment is used for extraction of HAp from bone and this temperature gives a higher strength to HAp structure. The high temperature also burns away any organic molecules such as collagen protein. Hydroxyapatite, found in fish is chemically similar to mineral components of bone and hard tissues in mammals. Approximately, 65-70% of the fish bone is composed of inorganic substances. Almost all these inorganic substances are hydroxyapatite composed of calcium, phosphorous, oxygen and hydrogen.

Pigments: Astaxanthin, fucaxanthin, melanin etc. from different fish resources are found to have a variety of bioactive properties. The filleting discards of salmonids and the shell wastes of crustaceans contain significant amounts of carotenoid pigments such as astaxanthin and canthaxanthin. Normally, wild caught shrimps will have more pigmentation compared to their cultured counterparts. For eg.level of astaxanthin in wild caught *P monodon* is reported as 55 mg /kg as compared to 18mg/kg for cultured variety. The carotenoid content in normal individual of *P monodon* is reported very high (78-80%) as compared to their blue varieties (7-8%). Total carotenoid content varies between species and body components. Highest carotenoid content was reported in the head of deep-sea shrimp (*A alcocki* 180-185 μg/g) and marine shrimp (*P stylifera* 150-155 μg/g) followed by *P monodon* (120-135μg/g), *P vannamei* (120-130μg/g). High levels of carotenoids were also reported in carapace of *A alcocki* (115-120 μg/g), S *indica* (117-120.0 μg/g) and *P stylifera* (100-105μg/g). Relatively low levels of carotenoids were reported in shrimp *P indicus* and fresh water prawn *M. rosenbergii* and crabs. The protective role of carotenoids against the oxidative modification of LDL cholesterol could be explored by incorporating in health drinks. Carotenoids are also highly sought after as natural food colours. Cephalopod ink is another less-tapped reservoir of a range of bioactives having therapeutic and curative values. It is an intermixture of black pigment melanin, glycosaminoglycans, proteins, lipids, and various minerals. Cephalopod ink has been reported to have anti-radiation activity, antitumor activity, immunomodulatory activity, procoagulant function and so on.The pigment melanin can be used both as a natural colorant as well as antioxidant, in addition to a number of other therapeutic and prophylactic properties including anticancer, antihypertensive, Anti IDA etc.

Pearl Essence

Pearl essence is the suspension of crystalline guanine in a solvent,. It is the irridescent substance located in the epidermal layer of the scales of the pelagic fish. This is used for coating the objects to give them a lustrous effect. The scales are placed in 10-15% brined solution and the brine is later drained and scaled squeezed and compressed. Pearl essence is extracted by washing and scruibbving the quinine form the scales. Centrifugation is carried out for separating the pearl essence from wash liquid. For purification of quinine, the protein concentrate is digested with pepsin in acid at 25- 30 ^{0} C for 50 hours. Fat is removed with benzene or ether. Finally guanine is removed by centrigufation and suspended in water or in non aqueous liquid.

Fish glue

Fish glue is made from fish skins (the better quality flue) and of fish heads (the lesser quality flues). Skin can be salted for shorter period of storage but can be dried for longer period of storage. For extracting glue .for extracting glue from fish skin, the skins are initially cooled and the chloride is removed to less than 0.1% by washing. For 1-2 hours if fresh and 12 hours if they are stored) in cold running water in a roller mill. After the water treatment, the skins are placed in 0.2% NaOH or CaO, neutralized with 0.2% HCl, and again rinsed in running cold water. The skins now swollen are mixed with an equal weight of water and steam is added. Addition of 1.9 litre of glacial acetic acid during heating will a make the final glue a clearer product. First cooking is for eight hours and the glue layer is strained. Subsequent cooking will give a weaker glue.

Fish maws and Isinglass

The word isinglass is derived from the Dutch and German words which have the meaning sturgeon's air bladder or swimming bladders. Not all fish air bladder are suitable for isinglass production. The air bladder of deep water hake is the most suitable for production of isinglass. In India air bladders of eel and cat fishes are used for the production of isinglass.The air bladders are separated from the fish, and temporarily preserved in salt during transport. On reaching the shore, they are split open, thoroughly washed and the outer membrane is removed by scraping and then air dried. The cleaned, desalted, air dried and hardened swimming bladders (fish maws) are softened by immersing in chilled water for several hours. They are mechanically cut into small pieces and rolled or compressed between hollow iron rollers that are cooled by water and provided with a scraper for the removal of any adhering dried material. The rolling process converts the isinglass into thin strips or sheets of 1/8 to ¼ "; thickness. There are processes for the production of isinglass in powder form.

Isinglass dissolves readily in most dilute acids or alkalis, but is insoluble in alcohol. In hot water isinglass swells uniformly producing opalescent jelly with fibrous structure in contrast to gelatin. It is used as a clarifying agent for beverages like wine, beer, vinegar etc. by enmeshing the suspended impurities in the fibrous structure of the swollen isinglass. India exports dried fish maws, which form the raw material for the production of isinglass and such other products. Process has been developed to produce the finished products from fish maws.

Further reading

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Extrusion technology for the development of snack products enriched with fish

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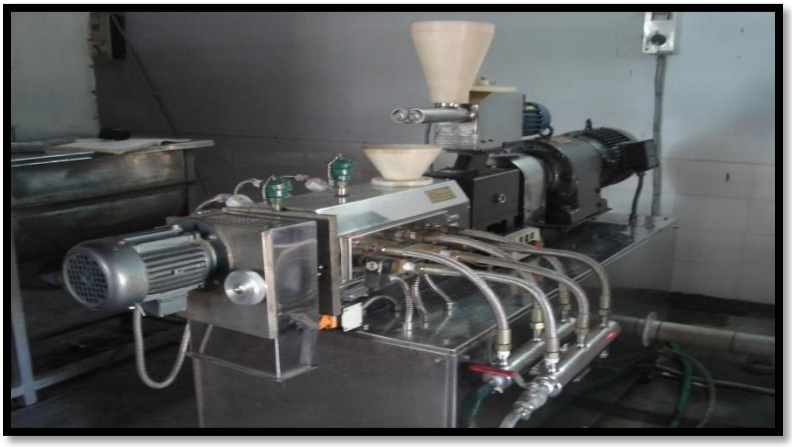
Food extrusion is a size enlargement process where small granular or powdered particles are reinforced into larger sized particles with different shapes, texture, colour etc. It is used for the manufacture of food products such as ready-to-eatbreakfast cereals, snack foods, soft moist pet foods and textured vegetable protein. 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 provides a great versatility for the development of low-cost, high-nutritive and convenient food products such as cereal-based snack food products. Extruded snacks are gaining importance now-a-days due to their peculiar taste, texture and convenience.Food extrusionis a size enlargement process where in small granular food or powdered particles are reinforced into larger pieces with different shapes, texture, colour etc. Extruded products 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 alleviating this problem is to utilize fish and fish proteins to enrich cereal-based extruded products. Demand for fish meat and fish meat-based products is increasing and utilization of by-catch, low-cost and underutilized fish and shellfish is given greater emphasis. Utilizing fish meat and fish portions and its derivatives like fish protein hydrolysate powder, dry fish powder etc.to develop extruded products will add value to the low-cost and underutilized fish and shellfish, thus promoting their utilization.

Extruders

Extruders are the tools used to introduce mechanical shear and thermal energy to food ingredients.Extruders are classified into two according to operation: Hot and cold extruders. Based on type of construction extruders are classified into: Single screw and twin screw extruder. Twin-screw extruders are used for high-moisture extrusion, products that include higher quantities of components such as fibres, fats, etc. and for the production of more sophisticated products. Twin screw extruders are again classified as co-rotating and counter-rotating types based on the direction of rotation of the screws. In the counter-rotating position the extruder screw rotates in the opposite direction, whereas in the co-rotating position the screw rotates in the same direction.



Twin screw extruders consist of five main parts:

(i) Pre-conditioning system

(ii) Feeding system

(iii) Screw

(iv) Barrel

(v) Die and cutting mechanism

Pre-conditioning is not applied to all extrusion processes. It is applied when moisture contents around 20 to 30% and long residence times are required for of the material. Pre-conditioning favours uniform particle hydration, reduces retention times within the extruder and increases throughput and increasing the life of the equipment, due to a reduction in the wearing of barrel and screw components. It also reduces the cost of energy involved in the process.

The feeding system is normally composed of a holding bin where the material is loaded and the discharge of the material can occur through a vertical or horizontal feeding screw. It ensures a constant and non-interrupted feeding of the raw materials into the extruder for an efficient and uniform functioning of the extrusion process.

The screw of the extruder is its most important component. It determines the cooking degree, gelatinization and dextrinization of starch and protein denaturation and also ensures final product quality. Screws can be mono-piece or multi-piece. Screw elements can vary in number and shapes, each segment is designed for a specific purpose. Some elements only convey raw or pre-conditioned material into the extruder barrel, while other segments compress and degas the feed. Others promote kneading, backflow and shear.

Barrels or sleeve surrounds the screw and are often jacketed to permit circulation of steam or superheated oil for heating or water or air for cooling, thus enabling the precise adjustment of the temperature in the various zones of the extruder. Generally barrels are equipped with pressure and temperature sensing and temperature control mechanisms. The barrel is divided into feeding, kneading and high pressure zones.

The die has two main functions: to give shape to the final product and to promote resistance to the material flow within the extruder permitting an increase in internal pressure. The die can be in various designs and number of orifices. Dies are usually designed to be highly restrictive, giving increased barrel fill, residence time and energy input.

The cutting mechanism is necessary for obtaining final products with uniform size. Product size is determined by the rotation speed of the cutting blades. This mechanism can be horizontal or vertical.

Principle of extrusion cooking

Raw materials (cereal flours and fish meat/fish protein hydrolysatepowders) are fed into the extruder barrel through a feeder and the screws convey along it. Towards the barrel end, smaller flights restrict the volume and resistance to movement of the food is increased. As a result, it fills the barrel and the spaces between the screw flights and becomes more compressed. As it moves further along the barrel, the screw kneads the material into a semi-solid, plasticized mass. The food is heated above 100˚C and the process is known as extrusion cooking (or hot extrusion). Here, frictional heat and the additional heating that is used cause the temperature to rise rapidly. The food is then passed to the section of the barrel having the smallest flights, where pressure and shearing is further increased. Finally, it is forced through dies (restricted openings) at the end of the barrel. As the food emerges under pressure from the die to normal atmospheric pressure and temperature, it expands to the final shape, gets characteristic texture and cools rapidly as moisture is flashed off as steam.

Coating of extruded products

The flavouring of extruded products follows a similar pattern to colouring. A product with fish incorporated has characteristic fishy flavour and it may develop further flavours by thermal reactions between flavour precursors in the mix or be flavoured by adding synthetic or natural flavorings. 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.This can be performed with simple rotating drums with electric heaters installed or with a gas operated hot air installation.

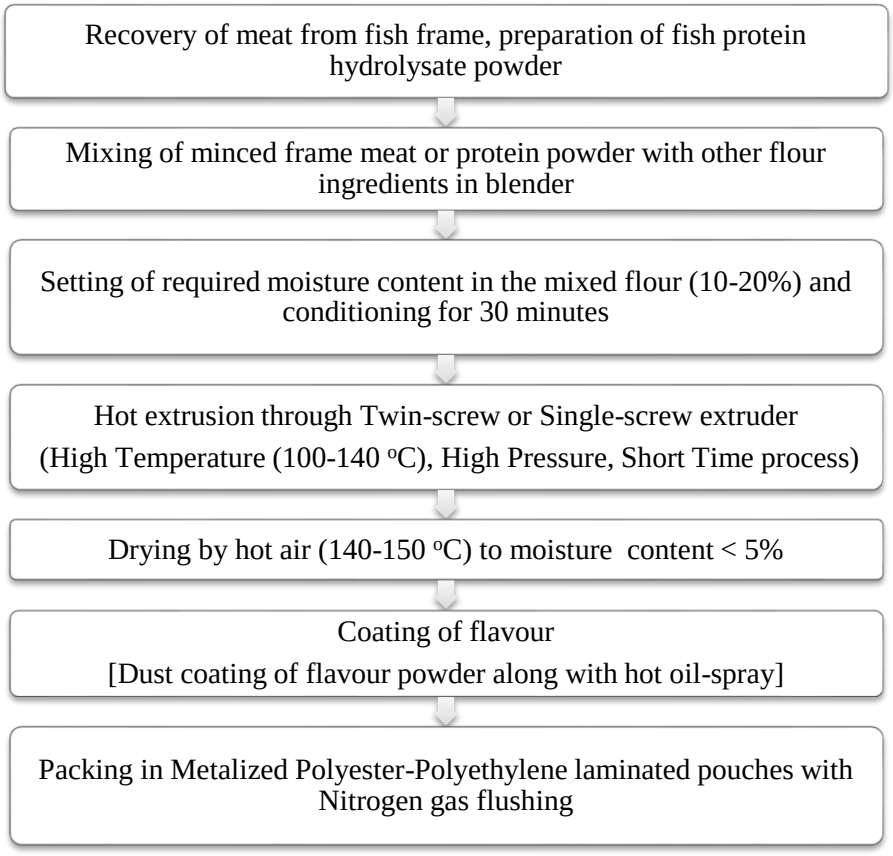
Packagingof extruded products

One of the major properties of snacks is the crispness, which is achieved during the manufacture of the product. Retention of desirable texture (crispness) is directly related to the moisture level in the product.The moisture content of snack is very low, and any increase due to the hygroscopic nature of the product may lead to loss of crispness of the product.Moisture also accelerates other biochemical changes such as oxidative rancidity. Oxygen inside the package may be replaced by an inert gas like Nitrogen. Low water vapour and gas permeability of the package is, therefore, a very critical requirement. Also the packaging material must be physically strong enough to withstand the processes of vacuumising/gas flushing. Metalized Polyester-Polyethylene laminated pouches with Nitrogen flushing are used for the packaging of extruded products.

Storageof extruded products

Extruded product can be stored at ambient temperature. Nitrogen flushed pouches can be bulk packed in carton box and stacked inside the store.Generally the shelflife of properly packed extruded products is four months.

Procedure for the preparation of extruded snacks enriched with protein from fish



Advantages of extrusion cooking

- 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 yields - operate continuously and have high throughputs
- Good quality nutrient enriched products - involves high temperatures 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

Extruded products and technologies developed and commercialized by ICAR-CIFT

ICAR-CIFT has developed technologies for the preparation of extruded products fortified with fishery products and by-products such as fish meat, cooked red meat from tuna canning industries, fish protein hydrolysate powders, dried seaweed powders. Apart from these, technologies for various agri-based products such as dried jack fruit seed powder, coconut milk residue, coconut haustorium etc.were also developed in collaboration with institutes like ICAR-CPCRI, Kasargode, CARD-KVK, Pathanamthitta etc. Various products were developed in ICAR-CIFT and commercialized through the Business Incubation Unit to several entrepreneurs.

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Sustainable food value chains andopportunities for entrepreneurship development: Concept and the case of marine fishery in India

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Introduction

It is estimated that by the year 2050, the fish production in India has to improve to the tune of 13.8 million tonnes, warranting a production improvement of 62% compared to current level. Further, fishery has been recognised as a sunrise sector, and the export demand from the sector is bound to increase. The sector has to grow sufficiently enough to absorb growing labour force in India. In order to achieve this, the major drivers of growth in the constituent components need to be identified and prioritised for investment. In that milieu, the marine sector needs to focus on sustainability and the inland sector has to focus on intensive production without hampering the environmental health. In order to turn the increased production to increased value, post-production operations needs to be enhanced focusing on value addition, improved marketing and exports. Ensuring safety, quality and traceability in the entire value chain is critical in this attempt. This indicates that the value chains in fisheries needs to be sustainable in terms of its effect in environment, economy and society.

Fisheries and value chains

The growth in the fisheries sector is much higher than that witnessed in other sectors of agriculture. The sector is also highly linked with external markets thorough trade relations. The sector provided employment and livelihood security through about 14-15 million people in India. The sector witnesses sign of economic, technological and financial duality. This is because one can visualize co-existence of highly technologically advanced fishing sector with relatively technologically underdeveloped traditional sector. Thus, the value chain in marine fisheries portrays a picture of large variation. Further, emerging recognition that fish is a health food and the consumer preference for fish products and byproducts both as a food and as a medicine has opened bright business prospects. The central and various state governments provide financial support though various schemes to establish business units and handhold such enterprises at least in the initial phase of establishment. Further, the consumer is getting increasingly concerned about the safety and quality of fish. In this context, one can visualize a fast restructuring of the value chain in fisheries, particularly marine fish.

However, the concept of the value chain has acquired the element of sustainability into to so as to evolve into sustainable food value chain, as noted by Food and Agricultural Organization. Furhter,its usage has transcended from the level of a marketing management tool to that of a policy analysis one. A value chain describes the full range of activities which are required to

bring a product or a service from conception, through the different phases of production and delivery to final consumers (Porter, 1980). Often the concept of value chain is interchangeably used to notate a market chain, but there are very critical differences between them. While the market chain analysis intends to provide information on profitability for various agents along the market chain (Ferris *et al*., 2001), a value chain analysis describes the range of activities required to bring a product to the final consumer and, the extent to which intermediaries/agents gain from participating in the chain (Jacinto, 2004). In that context, a value chain describes the distribution of the benefits or value addition to different economic agents, and touches the realms of development economics. In the initial days of the development of the concept, it was used for analyzing a single company, a sector, an organization or a product; however, later it was developed to analyze single or multiple sectors and to develop policies.

Kaplinsky and Morris (2000) identify three sets of reasons for the importance of value chain analysis. With the globalisation of labour and capital, and emergence of division of labour, achieving efficiency of production has gained greater policy focus. The corporate world try to attain systematic competitiveness in the context of growing division of labour and global dispersion of production components so as to achieveefficiency in production to penetrate global markets. Value chain analysis is also done to understand the dynamic factors that plays, so as to make the best out of globalisation. This approach essentially focuses on markets, with the aim of achieving overall efficiency in terms of increasing productivity and reducing cost. However, the attainment of efficiency need to factor in the opportunity cost of the resources and optimise the benefits over a long period of time. The trade-off between efficiency attainment and equity in distribution of the benefits for the stakeholders has also attained significance. Development of a win-win situation calls for imparting efficiency in attaining targets while generating maximum benefits to the actors along the value chain. In that context, sustainability of the value chain emerges as an important consideration.

Porter's value chain concept

The concept of value chain has its origins from the commodity chain approach, which focused on the physical product flow from the producer to final consumer. Michael Porter (1985) put forwarded value chain as the value addition in competitive markets. It is the core element in the production-to-consumption chain of activities, within an organisation framework. The value added should be more than the marginal cost of that activity, for the particular intervention to be sustainable. However, the concept doesn't address the larger concern of economic development of the sector, but was limiting itself to the organisational management. Porter's VC concept in that way deals essentially with firm-level strategy and not with broader economic development.

In Porter's concept ,the activities of the firm can be broadly split into 'primary activities' and 'support activities', depending on the whole functioning (Figure 1). The primary activities include inbound logistics, which include sourcing of the raw material; operations which include conversion of the raw material into final products; outbound logistics which include system of distribution centres, wholesalers, retailers and consumers; services including trainings. The

primary activities, either alone or in combination of them are essential for the firm to develop the competitive advantage for the value chain to be economically successful. On the otherhand, the support activities assist the primary activities in helping the organisation achieve its competitive advantage. They involve procurement including quality management; technology development to obtain competitive advantage with in the organisation including development of online facility; human resource management which includes recruitment, trainings, motivation, competitive advantage etc.; and, managing firm infrastructure, including managing finances, legal structure, and management structure. A co-ordination of all the activities are necessary for successful value chain development.

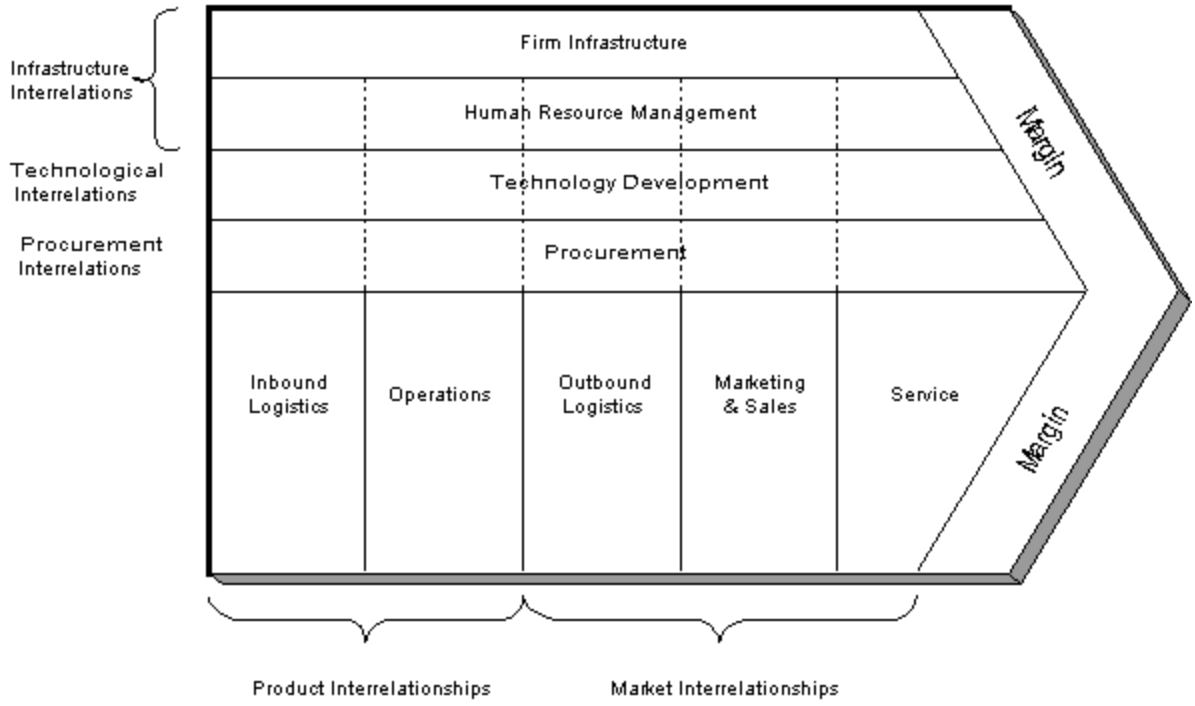

Figure 1: Michael Porter's value chain concept

Global Commodity Value Chain

On the otherhand, the global commodity value chain (GCV), as introduced by Gereffi and Korzeniewicz (1994), provides a developmental dimension, by introducing chain governance. The element of chain governance envisages how various firms across the entire chain are coordinated (or strategically linked) in order to be more competitive and add more value. Under this framework, the value chains are derived by the nature of demand from the final consumers and the process of globalisation.

The concept of global commodity value chain (GVC) shifts the focus of the analytical framework to demand side factors, compared to the supply side factors that areseen in case of Porter's value chain concept (Gereffi, 1994; Kaplinsky, 2000). This shift in the orientation of the value chain has been a result of the substantial influence that the global retailers wield over the food systems of the developing countries. The control is more forceful in those food commodities that undergo relatively low level of processing and therefore flexible. As the demand consideration varies across markets of different countries, primarily on account of different quality standards emphasised, the producing nation needs to take into account the cost of compliance. For example, the quality criteria prescribed by export markets like US is considerably different from that of Europe. This creates redefinition of markets according to quality criteria, and leads to an association which mutually reinforces quality and demand driven value chains. In such circumstances, the capability of the supplier to adhere to the quality prescriptions ceases to be a major consideration for the hegemonic retailers, and the sunk cost turns irrelevant. The cost of compliance could be prohibitively high for many firms, and the global hegemony of the retailers can be a critical factor that affects the sustenance of the value chain. One prime contribution of the global commodity value chain is the recognition of globalisation as a powerful economic phenomenon in determining food system performance and retailer hegemony as a prime factor that affect the value chain.

Sustainable food value chain

In recent times the value chain analysis has gained wide popularity, mainly to identify and prioritize the intervention points and development strategies for a sector. While the development economics has been focusing more towards the sustainability issues, value chain development literature has not addressed the issue of sustainability as the bottom line of developmental thinking (FAO, 2014). Of particular importance is how the value chain analysis addresses the issues of environment, economics and society at large. Further, the extant value chain framework is criticised for not being subjected to scientific scrutiny as well. The issues of food value chain are quite different from that of other value chain, as they have certain unique characteristics. Firstly,food is a social concern as it affects the health of all consumers, and, therefore, need to be subjected to larger public scrutiny. The factors like residential location of the consumers, habits and preferences related to food, place of origin, country of origin, form of food in terms of the extent of processing etc. have a strong impact on the nature of the VC. Second, the agricultural value chain in general and food value chain in particular affects the food and livelihood security concerns of large section of the population. This predisposes the value chain to larger political considerations. Third, the food value chain depends on the natural environment and, therefore, the costs needs to internalise the externalities out of the environmental factors (that are outside its reach). Four, the quality of food product is difficult to control, in terms of various parameters, and therefore, calls for institutional, organisational and technological interventions throughout the value chain.

The sustainable food value chain (SFVC) concept, as used by FAO, visualises an element of sustainability and applies it to specific nature of food production, value addition and distribution. However, many services used in a single commodity approach are common to many agricultural products- for example, marketing, financing, information etc are used by many commodities, and therefore a more holistic approach would gain currency in the times to come. However, for analytical purpose, the concept of SFVC has to look into commodity chains, so as to delineate the broader trends, identify intervention points and estimate the impacts. The concept of SFVC is relatively newer one, and is largely developed by FAO. Consequently, this session largely relies on the concepts as provided by FAO (2014).

SFVC can be defined as the full range of farms and firms and their successive coordinated value-adding activities that produce particular raw agricultural materials and transform them into particular food products that are sold to final consumers and disposed-off after use, in a manner that is profitable throughout, has broad-based benefits for society and does not permanently deplete natural resources (FAO, 2014). The concept is comprehensive in term of number of actors and the activities undertaken, and takes into consideration the external environment and vertical coordination in some activities. Full range of actors include the direct actors who own each component of the business as well as those who participate in service provision, like credit, R&D, market intelligence and other support services. Further, the concept gives emphasis for ecology as well, as it visualises a non-declining natural capital stock. The core economic activity in the entire process is value addition, through various activities like processing, storing, grading, transporting etc. The major component of the value added can be captured under five head, viz. (a) Salaries for employees; (b) Net profit for asset owners; (c) Tax revenues; (d) Consumer surplus (e) Externalities . The externalities can be positive or negative, or a combination of both. The externalities are unintended effects caused by an economic agent, which are not internalised in terms of compensation, such as increased pollution, biodiversity loss etc (which are negative in nature); and increased water availability useful for the locality(which emerges as positive).

The behaviour and performance of farmers and other agri-food enterprises are determined by a complex environment. The central element of the framework is the value chain actors, who form the core value chain. They represent those who produce or procure from the upstream level, add value to the product and then sell it on to the next level (FAO, 2014). The value chain actors could either be private sector enterprises (as in most cases) or public-sector as in case of Food Corporation of India (who collects foodgrains for buffer stocking as well for distribution through PDS outlets). In a value chain several such agencies can co-exist, who bears striking difference in terms of the size, technology, goals etc., catering to a multiple market segments.

The chain distinguishes four core functions (links): production (e.g. farming or fishing), aggregation, processing and distribution (wholesale and retail). Each of these steps involves costs, which vary depending upon the participants in the value chain. In a small holder dominated agrarian economy, aggregating and storing poses challenges, and will not allow economies of scale, and therefore may be costly. Institutional intervention, in terms of farmer's collectives or producer organisation can be a good option at these levels. Many agencies, including aggregators, distributors, processors etc can be a major actor at this point of time.

In the entire core value chain activities, the major element is value chain governance structure. It refers to the nature of linkages between various actors- both vertical and horizontal. The value

chain governance involves various core activities/ functions such as payment mechanisms, price determination, information exchange, market power, wholesaling etc. The value chain governance in that sense is a function of technology development, the extent of market imperfection, and rules and regulatory framework.

The support providers helps the value chain actors by providing essential roles that helps value creation by value chain actors. The SFVC visualises three kinds of support services

a. Physical input suppliers (such as seeds, irrigation, chemicals, ice, packaging materials etc.) at different levels of activity
b. Supply non-financial services (include transport, quality checking, market research, trainings, etc)
c. Financial services (Provision of capital in terms of credit, which requires growth of the banking systems).

The support system can arise from the public sector, private sector, NGOs, civil society organisations, farmer organisations etc. In some cases, all the services could be provided by a single agency, as a package. For example, many input dealers provide all the services together to the farmers, which may even to extent a buyback arrangement, not necessarily of a contract farming nature. In some cases the aggregator of the producer would be providing these services as a package along with the extension inputs.

Societal and natural environment

The external environment- like societyand natural conditions-exerts significant influence on the functioning of the value chain. The societal elements can be broadly classified into four types, viz informal socio-cultural elements (like religious requirements), formal institutional elements (like regulations, laws and policies), organisational elements (like educational facilities) and infrastructural elements (like roads, ports, communication networks etc) (FAO). The value chain operates in an enabling environment shaped by the domestic and international policies. The value chain which caters to the export market is influenced by the international environment more strongly compared to the one which caters more to the domestic consumers. The food safety regulations including CODEX Alimentarius, HACCP etc prescribed by the importing countries are costly and cost of compliance is higher. The certification procedures are tedious and needs international collaboration and verifications.

Interaction of economic, social and environmental elements

The sustainability of the value chain is determined by the economic, social and environmental elements. A value chain is considered economically sustainable if the required activities at the level are economically viable and or profitable. However, the outcome of the economic activity needs to be socially and culturally acceptable to characterise it to be socially sustainable. The environmental sustainability is attained largely if the value chain activities doesn't impact the environment adversely and maintains a non-declining natural capital stock.

Principles of sustainable food value chains

Though each food value chain is unique, the sustainable food value chain is characterised by 10 interrelated principles, as noted below:

a. Economically sustainable: Commercial viability, competitiveness, growth etc. The upgraded VC should provide higher profits, income etc.
b. Socially sustainable: Inclusiveness, equitability, social norms, social institutions and organizations. Generation of greater share of value (profit and wage income) to the poor, broad-based, and equitable distribution along the VC, with no adverse effect on the poor.
c. Environmentally sustainable: Non-declining natural capital stock, for inter-and intra-generational equity. Minimise environmental footprint (water footprint, carbon footprint etc) is an issue.
d. Dynamic and system based: VC is dynamic due to changes in market demand, technology, available services, profitability, risk, barriers to entry, large-firm behaviour, input supply and policy etc. VC needs to be adapt to changes. Sub-systems are linked, and identifying root cause in the system is the solution to improve.
e. Governance centred: Needs to analyse how value chain actors of different typology transact vertically and how they collaborate horizontally. The governance needs to bring in win–win solutions, and impart element of trust among the value chain actors.
f. End-market driven: The value is ultimately determined in the end-market when consumers purchase the product/service; and therefore consumer analysis needs to be the starting point for the VC improvement.
g. Vision/strategy driven: to be successful, the actors have to carefully target development goals and stakeholders. The strategies need to revolve around a vision which is realistic, quantifiable (as far as possible) and targeting (as far as possible) selected stakeholders. The improvement of VC should focus on that area where where largest impact is possible.
h. Upgrading focused: It requires carefully assessed and innovative upgrading activities to translate a vision and strategy into an effective plan. The upgradation can be in the form of technology, organisation, institution, network etc.
i. Scalable: The VC upgrade allow replication process that is based on realisitic assumptions.
j. Multilateral: It requires that the driver of the process of VC upgradation is private sector as driver and the other agencies (public sector and civil society organisations) as facilitators

The fisheries sector has grown in real term at a growth rate of 6.2% per year between 2004-05 and 2015-16. The differential growth rate in inland and marine sectors has led to increased share of inland fisheries, with an element of convergence of the growth. Both public and private sector has contributed to this growth story in terms of quality inputs, technology and extension services.

Further growth has to be brought through enhanced expenditure on fisheries research, education, and extension in all aspects of the value chain along with infusion of capital. Suresh et al (2018) has highlighted the need to prioritize the sectors to infuse capital, while achieving high level of efficiency. Focusing on harvest and post-harvest operations are critical in achieving higher value and income to the stakeholders. Overall, further growth in fisheries has to be achieved through careful prioritization with regard to sub-sectors, investment on research and development of infrastructure including markets.

Fishery sector in India: Trends and compositional change

The fishery sector has almost doubled the total value of output to reach Rs 635 billion in 2014-15, at an annual growth rate of 7.3%. This is constituted by annual growth rate of 9.5% in inland fisheries and 4.7% in marine fisheries. This differential growth has led to a change in composition of inland and marine fisheries in total value of output of fisheries, in favour of inland fisheries. In 2004-05, inland fishery accounted for 49% of value of output of fishery sector, which has changed to and 58% by 2014-15. The state-wise analysis indicates that as on 2014-15, Andhra Pradesh (undivided) accounts for close to 22% of value of output of total fisheries sector, closely followed by Bengal (21%). The major states involved are Tamil Nadu (6.1%), Gujarat (5.3%), Kerala (4.8%), Bihar (4.5%), Assam (4.4%), and Maharashtra (4.3%). A notable feature is the spread of fisheries sector to hitherto underdeveloped areas, coupled with a reduction in the share of the major producers. Among the major producers, the share of Andhra Pradesh, West-Bengal, Kerala and Tamil Nadu has reduced over the time. The analysis indicated that the fisheries sector growth is mainly propelled by inland fisheries. High growth of inland fisheries noted in Jharkhand, Haryana, Assam, Kerala and Rajasthan. It could be that there is scope for utilisation of inland water bodies and rivers for further augmentation of fisheries sector. In marine fishery sector, among major producers, the share West Bengal and Kerala has reduced sharply; whereas Gujarat, Tamil Nadu and Andhra Pradesh shows a slight decline. The paper calls for in-depth study to identify the drivers of fisheries sectors, both in the inland and marine sectors, so as to achieve a sustainable growth.

Sustainable Marine Fishery Value Chain in India

The concept of sustainable value chain is much applicable in fisheries sector. The sector provides livelihood to about 15 million people in India either directly or indirectly. The marine capture fishery sector in India has shown a deceleration in the growth performance, mainly on account of decline in stock reported to be due to several factors including climate change and over fishing. The participants in the value chain include traditional, motorised and mechanised sectors. The fish produced caters to the domestic market mostly in fresh form and export markets in processed form. Fish export is a major foreign exchange earner in India, and therefore are affected by national and international policy and political changes. The transmission of price signals affects the fish capture and processing. The high income incentives of capture fisheries and its processing have attracted investments in the sector. This has led to over-capitalisation, and consequentially over-extraction and stock depletion.

In order to address the sustainability issues of marine capture fisheries, large scale mechanised trawl fishing is banned for certain period during the breeding season of some fishes. This would have negative impact on certain stakeholders, including the labourers who are engaged in certain associated activities, but would have beneficial effect on catch and income in a sustainability perspective.

The domestic and international regulations on fishing, processing and quality control have significant influence on fish value chain, starting from production to waste disposal. Since fish is liable to quick perishability, it is subjected to strict quality controls adhering to stringent norms. The cost of compliance with the extant and emerging quality control norms is capital intensive, and therefore warrants institutional support and handholding in human resource development in the form of acquiring necessary skills. In the whole value chain, one of the major concernsis the extent of benefits accruing to the fisherman, the labourers involved, and, their linkages with the support system.

Entrepreneurship opportunities in marine fishery sector in the sustainable value chain framework

In the context of the evolving concept of sustainable food value chain, the marine fishery sector offers wide opportunity for entrepreneurship development. They include the realms spanning across Harvest and post-harvest technologies, vessel manufacturing/ servicing units, net fabrication and maintainance units, new and improved fish culture methods, Ornamental fishery, seed production technologies, development of detection/ diagnostic kits, waste utilization technology, byproducts development, quality management and test laboratories, processed food products including ready to eat and ready-to-cook product, development of machines for descaling fishes, fish feed manufacturing units, consultancy services, quality management, food packing material manufacturing, input supply, and other support services. The business incubation centres of ICAR-CIFT handholds the establishment of these units and provide technical services. Various government schemes including start-ups, make in India programme etc. provides financial services. NABARD provides financial help though various programmes SHG-Bank linkage, micro-finance and through Farmer Producer Organisations/Companies. A dynamic business leadership can effectively utilize the favorable ecosystem for formation of successful fishery based enterprises.

Further Suggested Readings

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Fish purchase and consumption: New trends and determinants

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Indian fishery has established as one of the fastest growing enterprising sectors in India and contributes 1.1% to national GDP and 5.15% to agricultural GDP of the country. With more than 14 fold increase in national fish production in just six decades i.e. from 0.75 million tonnes in 1950-51 to 13.7 million tonnes during 2018-19; India registers an unparalleled average annual growth rate in fishery that establishes its position as second largest in global fish production, next to China. In fact, the fish production in India has been doubled during last two decades (between 1995-96 and 2014-15) that engages more than 14.5 million people in fisheries activities for their livelihood giving a boost to foreign exchange earnings to the tune of US $7.08 billion (2017–18) through export of 13.77 lakh MT fish and fisheries products, which amply justifies the importance of the sector on the country's economy and in livelihood security.

Seafood is considered as an important part of a healthy and balanced diet by most consumers. It's been estimated that around 60 per cent of the Indian population consumes fish and the consumption pattern varies widely and across the different social fabric (Shyam, et al. 2013). The annual per capita consumption of fish for the entire Indian population is estimated at 5-6 kg whereas for the fish eating population it is found to be 8-9 kg. Average annual per capita fish consumption is highest in Kerala state at 30 kg which is very high compared to that of other states of India (Shyam, et al. 2015).

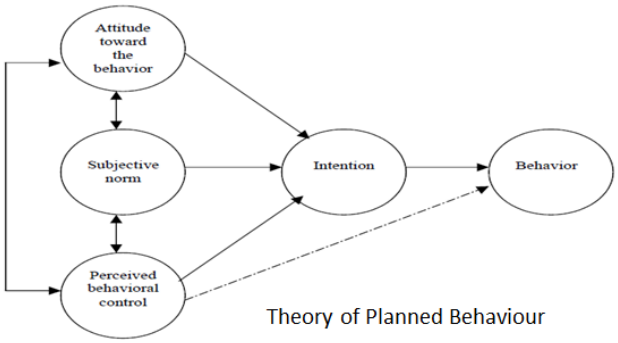
However, Indian consumers are forced to buy fish from unhygienic markets and vendors. In general, the fish supply chain follows a four-day cycle, wherein all parties don't necessarily conform to scientific food safety norms. Without a proper cold chain, bacterial contamination typically starts within 30 minutes. Poor quality ice and preservatives like sodium benzoate and formalin are used to keep the fish from deteriorating, which are potentially harmful and carcinogenic for humans (Ranganna, 2017). In recent times, the wide scale media highlight on fish adulteration has created an increased health concern and consciousness about safety and quality standards among consumers (Sajeev, 2018a). These issues have created new drivers and barriers to fish consumption with fish consumers changing their fish purchase behaviour and market choice. Fish vendors air concerns about urban consumers' inhibition to purchase from traditional markets due to increased safety and quality awareness. In this context, online fish marketing has emerged in a big way and is assumed to be disrupting traditional fish vending business (Sajeev, et al. 2018).Online fish marketing claims to provide fresh and chemical/pesticide free fishes, which gives them an edge over other fish retail sources. There is a

steady rise of e-commerce fish marketplace that has gained momentum with the rise of e-grocery and advent of new cost-effective freezing technology (Vishal, 2015).

Issues of fish adulteration have been widely discussed by media and have created an increased health, safety and quality consciousness among consumers. These issues have created new drivers and barriers to fish consumption with fish consumers changing their fish purchase behaviour and market choice. The article studies the emerging drivers and barriers to fish consumption using 'Theory of Planned Behaviour' (TPB)as a theoretical base.Later, the factors identified were consolidated into a framework of fish consumption.

Theory of Planned Behaviour

The theory of planned behavior (TPB) was introduced as an extension of Theory of Reasoned Action (TRA). The underlying concept of TPB says that person's intention to perform certain behaviour, which is defined as people's motivation, including the willingness to perform; is a latent variable and this variable is dependent on attitude and subjective norms (Ajzen, 1991; Petrovici, et al, 2004; Saba & Vassallo, 2002, Bonne et al., 2007).



Theory of Planned Behaviour

The perceived behavioural control (PBC) as the third construct is the extension of the TRA model to develop the TPB model. The unique nature of TPB model is that it considers the non-economic factors, which are overlooked in traditional economic models (Petrovici, et al, 2004).

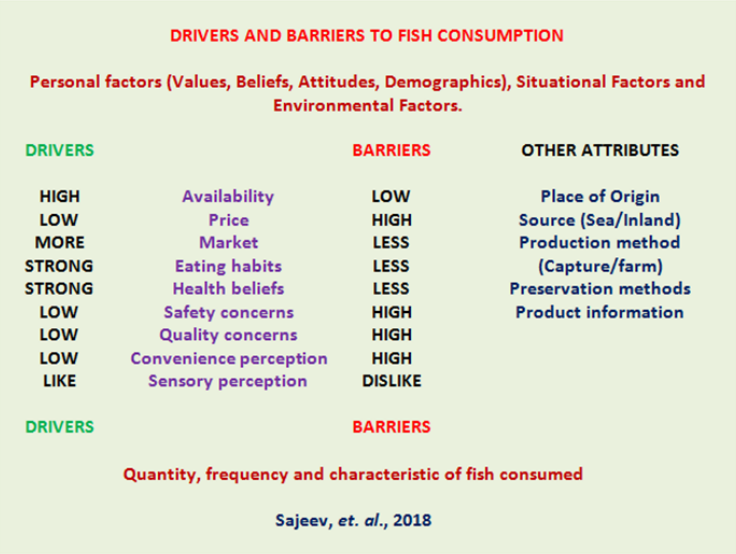
Determinants of fish consumption

Empirical evidence shows differences in the use of information sources by consumers depending on the food product, the communicated information and the potential health or safety risk (Gutteling and Wiegman, 1996; Jungermann et al., 1996). With respect to fish, consumers mostly use personal sources of information, such as fishmongers and family and friends (Pieniak et al., 2007).

Pieniak et al. (2010 a,b) identified knowledge as a relevant determinant of fish consumption. Consumers with a higher level of knowledge about fish were found to eat fish more frequently. Knowledge studies focused mainly on production aspects, whereas consumer information and education campaigns have mainly been focused on the health and nutritional benefits of fish, as well as on convenience issues acting as barriers to consumption (Olsen, 2003; Verbeke and Vackier, 2005).

Olsen in 2004 found four salient beliefs reasonable in forming seafood / food consumption attitude as: taste, distaste (negative affect), nutrition (Steptoe et al., 1995) and quality / freshness (Olsen, 2004). After the taste issues the nutritional aspects are the second prominent factor that affect consumer's food attitude, it is directly related to health and healthy eating behaviour (Olsen, 2001). The quality of the fish/seafood freshness is another prime determinate. In this regards, frozen fish are treated as "non-fresh" "bad quality" "tasteless" "watery" "boring" (Olsen, 1998). Olsen in 2004, found price, value for money and household income are not barrier in seafood consumption, while Verbeke & Vackier, in 2005, reported that price negatively affect the fish consumption attitude.

The review of the drivers and barriers to fish consumption using 'Theory of Planned Behaviour' as a theoretical base (Sajeev et. al., 2018) provided the following framework of determinants for quantity, frequency and characteristics of fish consumed.



New trends: Online fish marketing

Fish vendors doing business online sounds crazy in India where vendors have a virtual monopoly over door sales of both sea and inland fish. Moreover, fish being a highly perishable product, the

idea was found too difficult to implement unlike other consumables where online marketing rules the roost. However, things changed drastically over the last couple of years particularly in urban areas.

Often referred to as 'online marketing', 'internet marketing' or 'web marketing', digital marketing/E-marketing has gained popularity over the past decade. With the arrival of social networks, e-marketing now also boasts of a new branch of social media marketing. Even though the term 'digital marketing' was coined in the 1990s, its complete usage and importance has risen only in the recent past. As technology advanced rapidly over the past two decades, digital media became so widespread that anybody could access information anytime, from anywhere.

E-Marketing stands for electronic marketing, is also known as Internet marketing. In contrast to traditional marketing, E-Marketing takes marketing techniques and concepts, and applies them through the electronic medium of the internet. Essentially, E-marketing threads the technical and graphical aspects of online tools together, allowing for design, advertising, brand development, promotion and sales. Internet marketing offer the possibility to tracking almost every action a visitor or potential customer takes in response to marketing messages and how they navigate through their buying cycle. One of the most desirable aspects of Internet marketing is low barrier to entry. "Digital marketing/e-marketing as the name specifies is marketing over the internet through various digital devices".

Online marketing giants such as Amazon and Flipkart have been showing tremendous growth over the years in Indian e-retail market space. Hence, idea of e-markets is not new for Indian customers and they have become used to it. But fish being a highly perishable commodity, adhering to quality standards makes its sales, marketing and promotion a risky affair. Sustenance of online fish marketing depends on providing fresh and affordable fish to the consumers on time. This distinguishing factor makes online fish marketing an interesting topic of study.

With an increased knowledge, attitude and better perception about health, quality and safety issues related to fish consumption, customers are fast switching to online fish markets.Orders are just a touch away on android mobile apps, websites, facebook page, Whatsapp message, an SMS or a call. More than a dozen e-commerce sites; www.freshtohome.com, www.dailyfish.in, www.mathafreshfish.com, www.suvichar.in, www.onedaycart.com, www.freshandhealthy.in, www.wildfish.in, www.biggro.com, www.healthyfishonline.com, www.onedaycart.com, www.onlinekochi.com, www.nallameen.com, www.bigbasket.com etc are into business and is expanding their market base day by day (Cynthia, 2016). These fish E-commerce sites offer a rich array, mostly the variety available on local coast. Pre-ordered fresh fish reaches consumers' doorstep in curry cut, steak, fully cleaned or even as whole fish at prices affordable to the discerning homemaker. More than price, the focus in e-marketing of fish is on quality and safety

(Sajeev, 2018b). Some online sites charge for delivery while others do it for free. However they are still far away from disrupting traditional fish vending systems.

Conclusion

Fish purchase and consumption is a dynamic process that is constantly evolving and changing.Consumer focus is shifting to quality and convenience rather than price. Online fish marketing is far away from disrupting traditional vending and sustainability of online fish marketing counts mostly on consumer satisfaction and continued patronage.Maintaining the choice of products, better price range, quality and safety guarantees, delivery systems and improved consumer accessibility over mobile and social media platforms are found to drive growth in online fish vending sector.

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Consumer behaviour analysis: Lessons for entrepreneurship development

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Introduction

An entrepreneur faces a multitude of challenges in navigating the business environment of his/her firm. One of the most critical component determining the success of an entrepreneurial venture is the customer for the product or service offered by the enterprise. In this context, understanding the consumer assumes strategic significance for the survival and performance of the firm. Though consumer behaviour and its application is a relatively new area of serious academic pursuit, the academic interest in consumer behaviour has seen several shifts in its core focus over the decades.The study of consumer behaviour evolved during the early 1940s as an independent area of study as a sub discipline of marketing research. Later on consumer behaviour studies started to integrate information and tools from diverse fields of social sciences and took on the character of an inter-disciplinary social science.

The advances in data access, processing and analytics have lent several insights into consumer behaviour which challenged conventional wisdom. Modern firms actively leverage their customer data base to gain insights on consumer behaviour and to deploy strategies which can utilize this information to their best advantage. This chapter will discuss various aspects of consumer behaviour from the point of view of an entrepreneurial firm. The first section following the introductory section discusses the scope of consumer behaviour studies. The consumer purchase decision process is outlined in the next section followed by a brief description on the external and internal factors influencing the purchase decision of a consumer. A section on the consumer behaviour in the virtual world, which is fast gaining significant market share among various market channels, follows. Some of the major areas of consumer behaviour studies are described in the next section. Some of the key behavioural biases of consumers having a significant impact for the choice of marketing strategies is described in the concluding section.

The domain of consumer behaviour

Any individual who purchases goods and services from the market for end-use is called a consumer. In simpler words a consumer is one who consumes goods and services available in the market. Consumer behaviour is the study of individuals, groups, or organizations and all the activities associated with the purchase, use and disposal of goods and services. It entails all activities associated with the purchase, use and disposal of goods and services, including the consumer's emotional, mental and behavioural responses that precede or follow these activities (Kardes et. al., 2011). The term, consumer can refer to individual consumers or organisational consumers. From the definition of consumer behaviour it follows that the study of consumer behaviour is concerned with purchase activities (how consumers acquire products and services, and all the activities leading up to a purchase decision), use or consumption activities (who,

where, when and how of consumption and the usage experience) and disposal activities (concerning the way that consumers dispose of products and packaging).

As an inter-disciplinary social science, consumer behaviour studies blend elements from other disciplines like, sociology, anthropology, ethnography, marketing and behavioural economics. It examines how emotions, attitudes and preferences affect buying behaviour. Thus the characteristics of individual consumers such as demographics, personality lifestyles and behavioural variables such as product usage rates, usage occasion, brand loyalty, etc are all investigated in studies of consumer behaviour. As a field of study, consumer behaviour is an applied social science. Consumer behaviour analysis is the use of behaviour principles, usually gained experimentally, to interpret human economic consumption (Gordon, 2001). The study of consumer behaviour also investigates the influences, on the consumer, from groups such as family, friends, sports, reference groups, and society in general.

Alternately consumer behaviorcan also be viewed as the study of individuals and organizations and how they select and use products and services concerning mainly with the psychology, motivations, and behaviour underlying the consumer behaviour and the impact of these transactions on the society.The study of consumer behavior includes:

- How consumers think and feel about different alternatives How consumers reason and select between different alternatives
- The behavior of consumers while researching and shopping
- How consumer behavior is influenced by their environment
- How marketing campaigns can be adapted and improved to more effectively influence the consumer

The purchase decision process

The purchase decision process of the consumer lies at the core of the consumer behaviour analysis. The entire process is usually depicted as consisting of 5 distinct stages (Khosla, 2010). The following section follows the five stages of buying process described by Philip Kotler.

- Problem Identification
- Information Search
- Evaluation of Alternatives
- Purchase Decision
- Post-purchase Decisions

Problem recognition: The purchase decision begins with the *problem recognition* stage which occurs when the consumer identifies a need, typically defined as the difference between the consumer's current state and their desired state. The perception of the need is the starting point of the purchase process. The strength of the need influences the entire decision process involved in purchase.

As and when theconsumer identifies a problem, he or she is 'in the market' for a product or service to satisfy some need or want which shall adequately address the identified problem. The nature of problem solving could be extensive problem solving requiring greater deliberation,

extensive information search and evaluation alternative options. This kind of problem solving is required for expensive purchases, or purchases with high social visibility e.g. luxury fashion jewellery, cars etc. A limited problem-solving approach could be adopted for lower priced purchases where the products are relatively familiar and are purchased at relatively frequent intervals. Repeat purchases or habitual purchases of consumption items like products for daily use require very little active mental processing.

The consumers become aware of a problem in a variety of ways. The natural depletion of the product in use, regular purchase items, dissatisfaction with existing product or service, changes in life style requiring new need and wants, marketing induced perception of problem recognition and the appeal of new and innovative products are some of the ways in which the consumers are drawn into problem recognition.

Information search: The aim of the information search is to identify a list of options that represent realistic purchase options. The consumers scan both their internal memory and external sources for information about products or brands that will potentially satisfy their need. The search for information about the potential products that can address the identified problem could be either internal search, external search or more typically a combination of both. Typically consumers first carry out an internal search; that is a scan of memory for suitable brands. Usually the internal search yields about a small set of 3- 5 alternatives.

Consumers may choose to supplement the number of brands in the evoked set by carrying out an external search using sources such as the Internet, manufacturer/brand websites, shopping around, product reviews, referrals from peers and the like. As the consumer approaches the actual purchase, he or she distills the mental list of brands into a set of alternatives that represent realistic purchase options, known as the consideration set. This set excludes products that are beyond his economic means, below his basic expectations vis a vis his identified problem resolution. The small set of brands which a consumer pays close attention to when making a purchase decision is termed as the consideration set. Traditionally, one of the main roles of advertising and promotion was to increase the likelihood that a brand name was included in the consumer's evoked set.

Evaluation of alternatives: Throughout the entire purchase process, the consumer engages in a series of mental evaluations of alternatives, searching for the best value. Though consumer evaluation is pervasive during the entire purchase process, it can be viewed as a distinct stage. Consumers evaluate alternatives in terms of the functional (based on utility and tangible outcomes of the product/service including parameters like taste or physical appearance) and psycho-social (symbolic) benefits offered. The Psycho-social benefits are the more abstract outcomes such as the social acceptance of the product, peer recognition that might accrue from wearing a product etc. An entrepreneur needs a deep understanding of the benefits most valued by consumers and therefore which attributes are most important in terms of the consumer's

purchase decision to leverage the evaluation process in his favour. It should also be kept in mind that the evaluation process could vary across products, channel and purchase situations. Typically, a consumer after evaluating the different product attributes, ranks each attribute or benefit from highly important to least important keeping priorities related to the consumer's needs and wants in mind.

Purchase decision: The self instruction to make a purchase is known as *purchase intent* follows the process of evaluation of alternatives. This firm resolve constitute purchase decision. Even then, the intention is considered to be an imperfect predictor of actual purchase since the intentions do not translate into actual sales in many cases. The non-availability of the product availability information could , for example create a barrier between intension and actual purchase. Firms use a variety of techniques to minimize such barriers. Provision of credit for purchase, advertising messages with strong call-to action content etc are two of such strategies. These strategies provide consumers with compelling reasons to purchase promptly rather than defer purchase decisions.

Post-purchase evaluation: The final stage in the purchase process is the post-purchase evaluation. The consumer examines and compares product features such as price, functionality, and quality with their expectations formed before the purchase. The consumer's purchase and post-purchase activities have the potential to provide important feedback to marketers (Foxall, 2005).The post-purchase evaluation influences future purchase patterns and is important in developing favourable purchase decisions in future. Marketing communication at this stage could be tailored to help the consumer in generating a positive validation of the purchase that he/she has made.

The stages of the purchase process implies a clear cut sequential process proceeding from one stage to the next. In practice, it need not be like that. Though the stages of the decision process normally occur in a fixed sequence, it should be noted that information search and evaluation can occur throughout the entire decision process, including post-purchase.

Influences on purchase decision

The previous section outlined the process of purchase through various stages involved. Understanding the factors that influence the purchase decision is equally important for an entrepreneur. Purchasing is influenced by a wide range of internal and external factors.

Internal influences

Internal influences refer to both personal and interpersonal factors. The internal factors comprise of psychological, demographic and personality factors. Income level, age, occupation and socio-economic status are examples for demographic factors whereas an individual's motivation, attitudes, personal values and beliefs are examples of psychological factors. These internal

influences are not independent of each other. The effect of these internal factors often difficult to isolate. Among these internl factors influencing purchase decision motivations and emotion play a major role.

The consumer's underlying motivation drives consumer action, including information search and the purchase decision. Even the consumer's attitude to a brand isdirectly linked to his motivations. One of the most commonly used models in understanding motivation was developed by Abraham Maslow. Maslow's hierarchy of needs is based on five levels of needs, organized accordingly to the level of importance. These five needs are physiological needs, safety needs, need for belonging, need for esteem and the need for self actualization. Physiological needs and safety needs are the so-called lower order needs whereas esteem and self-actualization are considered as the higher order needs. Part of any marketing program requires an understanding of which motives drive given product choices.

Rossiter and Percy (1991) developed another approach to understand the purchase motivation with five negative motives and three positive motives, which energise purchase decisions as illustrated in the table below.

Table 1:Rossiter and Percy's Purchase Motivations & Emotions

Motivation	**Emotional Sequence**
NEGATIVE	
Problem removal	Annoyance → Relief
Problem avoidance	Fear → Relaxation
Incomplete satisfaction	Disappointment → Optimism
Mixed approach avoidance	Conflict → Peace-of-mind
Normal depletion	Mild annoyance → Convenience
POSITIVE	
Sensory gratification	Dull (or neutral) → Sensory anticipation
Intellectual simulation	Bored (or neutral) → Excited
Social approval/ conformity	Apprehensive (or ashamed) → Proud

Perception and external influence

The customer has to perceive the information about the product and gain awareness about the product during the resolution of the identified problem and search for information. The perception process is where individuals receive, organize and interpret information in order to attribute some meaning. Consumer behaviour involved in how consumers gain knowledge and use information from external sources forms a part of marketing strategy. Sensing , selecting and interpreting information are the key steps involved in perception. The process of perception is linked to brand preference, impact of advertising and response to packaging and market promotional offers.

External influences

Purchasing behaviour can also be affected by external influences, such as culture, sub-culture, social class, reference groups, family and situational determinants. One of the more abstract concepts, culture refers to the complexity meanings, values, norms, and customs shared by members of a society. The norms determined by culture tend to be stable over time and act as a major source of influence on every aspect purchase decision. Culture also has an impact on other internal influence factors like motivation, self identity, attitudes etc. Therefore the role of culture should be understood against the back drop of the social setting of the consumer. The understanding of cross cultural influences on consumer behaviour is key for market expansion of a firm. Within a culture, the consumer behaviour differs based on differences in age, sex, geographical region, religion, ethnicity etc. These factors which create sub groups within a single culture and lead to behavioural differences are called sub-cultures. Members of subcultures are self-selected, and signal their membership status by adopting symbols, rituals or behaviours that are widely understood by other members of the sub culture. A shared commitment to a common brand or product could also be the basis for sub culture. Eg;- ownership of premium vehicle brands like Harley Davidson motor cycles. These sub cultures are Subcultures are important to marketers to fine tune the product design, marketing strategies and market promotion offers.

Social class and reference groups are two other external sources of influence on purchase decision and consumer behaviour. Social class refers to the divisions in a society based on socio-economic variables such as educational attainment, income and occupation. The market share, spending ability and the type of products demanded by each of the social class differ based on these variables which are used to categorize them. The reference group is the group of individuals whose perspectives, values or attitudes are being used by an individual as the benchmark for his or her judgment. They are important because they are used to guide an individual's attitudes, beliefs and values during the process of purchase. The literature identifies five broad types of reference group; primary, secondary, aspirational, dissociative and formal.

Groups such as family, that exert a strong influence on attitudes and behaviours of an individual are called primary groups. The secondary group consist of groups such as clubs, political parties, teams, societies which align closely with a persons value system or attitudes. There are certain groups to which the individual might not currently belong, but aspires to do so. These groups form the aspirational reference group. The individual will try to match the choices made by this aspirational group while considering purchase decisions. Dissociative reference groups have a negative image. The individual disapproves the values and attitudes of this group and does not want to follow any of their consumer behaviour patterns so as to distance himself/herself from the dissociative group. Opinion leaders and people in formal authority positions which an individual approves constitute the formal reference group.

Consumer decision styles

All the factors and the purchase decision process interact with each other to create several distinguishable consumer decision styles. Consumer decision styles are important for marketers because they describe behaviours that are relatively stable over time and for this reason, they are useful for market segmentation. Sproles and Kendall (1986) developed a typology for consumer decision styles based on factors like price-sensitivity, quality-consciousness, brand-consciousness, novelty-seeking, fashion-consciousness and habit. They are outlined below

- **Quality conscious/Perfectionist**: Characterised by the search for the very best quality in products. Quality conscious consumers tend to shop systematically making more comparisons and shopping around to compare quality and value.
- **Brand-conscious**: Brand-consciousness is characterised by a tendency to buy expensive, well-known brands or designer labels.
- **Recreation-conscious/ Hedonistic**: Recreational shopping is characterised by the consumer's engagement in the purchase process. These consumers regard shopping itself as a form of enjoyment.
- **Price-conscious**: A consumer who exhibits price-and-value consciousness. Price-conscious shoppers carefully shop around seeking lower prices, sales or discounts and are motivated by obtaining the best value for money
- **Novelty/fashion-conscious**: characterised by a consumer's tendency to seek out new products or new experiences.
- **Impulsive**: Impulsive consumers buy on the spur of the moment and are not overly concerned with expenditure levels or obtaining value.
- **Confused (by over-choice)**: characterised by a consumer's confusion caused by too many product choices, too many stores or an overload of product information; tend to experience information overload.
- **Habitual / brand loyal**: characterised by a consumer's tendency to follow a routine purchase pattern on each purchase occasion. The purchase decision does not involve much evaluation or shopping around.

Consumer behaviour in context of purchase risk

A consumer faces several uncertainties and or adverse consequences while engaging in purchase activity. The quantum of perceived risk in purchase is important in guiding the pre-purchase process, evaluation of alternatives and the actual choice of the product/ service. The nature and type of risk associated with purchase varies with the type of product/ service under consideration. Mitchell and Boustani, (1994) identifies two dimensions of risk associated with purchse; *consequences* - the degree of importance or the severity of an outcome and *uncertainty* - the consumer's subjective assessment of the likelihood of occurrence.The marketing literature identifies many different types of risk, of which five are the most frequently cited

- Financial risk: the potential financial loss in the event of a poor decision

- Performance risk (also known as functional risk): the idea that a product or service will not perform as intended
- Physical risk: the potential for physical harm if something goes wrong with a purchase
- Social risk: the potential for loss of social status associated with a purchase
- Psychological risk: the potential for a purchase to result in a loss of self-esteem

The perception of risk determines the types and nature of strategies adopted by consumers to minimise such risks. If the consumers are unable to deploy risk minimization strategies and the perceived risk is high he/she may withdraw from the purchase. In terms of risk perception, there are three broad classes of purchase; search goods, experience goods and credence goods. Search goods, possess tangible characteristics that allow consumers to evaluate quality prior to purchase and consumption. Experience goods, such as holiday tours and restaurants, can only be evaluated with certainty after purchase or consumption. Those goods and services where it is difficult to evaluate the quality even after consumption are called credence goods. Consultancy services would be a typical example for this type of credence good.

Dowling and Staelin (1994) describe some of the common risk minimization strategies adopted by the consumers

- Paying close attention to product related advertising and promotional messages
- Comparing offers and prices, inspecting the merchandise by shopping around
- Using a known, reputable brand as an indicator of quality merchandise
- Relying on a reputable retail outlet as an indicator of quality
- Reading independent product reviews in main media and or consumer testimonials
- Sampling or Limited-scale Trial: Where practical, obtaining samples, free trial or a 'test-drive' prior to purchase
- Obtaining referrals from friends or relatives
- Talking to sales representatives in retail outlets
- Looking for formal guarantees or warranties

The consumer firm relationship: Brand-switching and loyalty

The relationship between a firm and the consumers of its products/ services is manifested in a variety of ways. Each firm looks to build a sustainable loyal customer base who would extend their patronage to the products and services offered by the firm for a long period of time. Typically a firm would like to avoid brand switching and promote brand loyalty. Customer citizenship involves higher order loyalty which would be still more desirable from the point of view of a firm. Brand-switching occurs when a consumer chooses to purchase a brand that is different to the regular or customary brand purchased. Consumers switch brands for a variety of reasons including the consumer's desire for variety or novelty. In the fast moving consumer goods market and packaged food industry, the incidence of switching is relatively high. Marketers are particularly interested in understanding the factors that lead to brand-switching. Better price, superior quality, and better service offers are some of the leverage points for

inducing brand switching. Improved product features of the competitor could also induce brand switching.

Customer loyalty is in a way the converse of brand switching and is described as the relationship between an individual's attitude and repeat patronage. Dick and Basu(1994) proposed four types of loyalty based on relative attitude and patronage behaviour

No Loyalty: Characterised by low relative attitude and low repeat patronage behaviour. **Spurious Loyalty:**Characterised by low relative attitude and high repeat patronage. Spurious loyalty occurs when the consumer undertakes repeat purchasing due to situational factors such as access, convenience or shelf placement. Spurious loyalty can also occur when there are no genuine alternatives.

Latent Loyalty: Characterised by high relative attitude and low repeat patronage. Latent loyalty occurs when situational factors over-ride strong favourable attitudes. **True Loyalty:**Characterised by favourable attitude and favourable patronage behaviour. For marketers, true loyalty is the ideal situation.

It costs 5-20 times more to acquire a new customer than to retain an existing customer (Gallo, 2014). Therefore efforts for building customer loyalty should be given high priority. A variety of loyalty programs are in vogue to develop and sustain customer loyalty and to minimise brand switching. Reward and recognition programs are commonly used by many firms to develop customer loyalty. Innovative use of data mining techniques leveraging the customer data base is an emerging area for gaining insights on customer loyalty and to design appropriate strategies to cater to various segments of loyal customers.

Consumer behaviour in digital platforms

Traditional models of consumer behaviour were developed more than 50 years ago. The marketing scenario and availability of market channel choice for the consumer has witnessed a sea change since then. Some of the marketing platforms were non-existent at the time these models of consumer behaviour was developed. Some scholars have argued that consumer behaviour in virtual world or more specifically, the online marketing channels is different to offline behaviour and as a consequence requires new theories or models.

The shopping experience in the online platform is different from other marketing channels. The customer derive satisfaction from their ability to navigate a website and the convenience of online searching which allows them to compare prices and 'shop around' with minimal time commitment . The consumers may use online platforms for various stages of the purchase decision, sometimes in isolation and sometimes in the entire purchase process.Marketers have segmented consumer markets into different kinds of online behaviour in accordance with their behavioural characteristics online. Lewis and Lewis (1997) identified five different kind of online consumers based on the way that consumers use the Internet in the purchase decision process

1. Directed Information-seekers:These users look for information about specific products. Their intention is not to buy but to search for information.

2. Undirected Information-seekers: These users regularly browse and change websites by following hyperlinks. They referred to as 'surfers' because they look around the websites to find something interesting. They are more willing to interact with the online advertisement designed by online marketers.
3. Directed Buyers:These users visit a website with the intention to buy products online. They search specific products and make the transaction.
4. Bargain Hunters:This type of users search to find special offers such as free samples or competitions. They are usually more price sensitive.
5. Entertainment Seekers:These users visit websites that offer entertainment features, such as quizzes, puzzles and multi-player games.

Leveraging cognitive biases for moulding consumer behaviour

The advances in behavioural economics using developments in related fields like neuroscience, experimental psychology etc. have given fresh insights on the working of the human brain. More specifically the work done by researchers like Daniel Kahneman have generated a large body of literature dwelling on the cognitive limits of human brain and the systematic biases generated in human thought process. An understanding of these cognitive biases can help in developing better marketing strategies and moulding consumer behaviour in desirable direction. Cognitive biases are systematic patterns of deviation from norm or rationality in judgment, and are often studied in psychology and behavioral economics. Some of the biases arise from the mental short cuts used for processing information while some of them arise from constraints in capacity for information processing. A knowledge of these biases can help in effectively influencing customer choice and decision making process. The list of biases is large, a few of these cognitive biases having an influence on consumer behaviour is briefly described below.

Anchoring Bias – People are overreliant on the first piece of information they hear.

Availability bias – When people overestimate the importance of information that is available to them.

Bandwagon Effect – The probability of one person adopting a belief increases based on the number of people who hold that belief.

Confirmation Bias – We tend to listen only to the information that confirms our preconceptions

Conclusion

Consumer behaviour analysis is the starting point for understanding the consumer as the key driver of growth of a firm. The structural framework for analysing consumer behaviour, the types of responses and the factors influencing these responses and behaviour can throw light on possible intervention points for effectively managing consumer behaviour in favour of the firm and its marketing objectives.

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Stakeholder Analysis for Entrepreneurship Development in Fisheries

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Stakeholder analysis is a process of systematically gathering and analyzing qualitative information to determine whose interests should be taken into account when developing and/or implementing a policy or program. Stakeholders in a process are actors either a person or group of person or an organization with a vested interest in the policy or enterprise. Stakeholders are the interested parties who expressed vested interest over the policies or developments. The stakeholders might be varied from international to national or regional. They can be of profit or non-profit making organization, governmental or non governmental institutions, civil society and consumers or users. The stakeholder groups are varied and different based on the purpose and goals of the study. The profile of stakeholders is given in Fig. 1.

Fig. 1. Stakeholders profile

Stakeholders feasibility analysis is inevitable for the successful initiation and execution of product or policy or enterprise. It is the process of conformingthe nature of stakeholders towards the product or enterprise development. It is an assessment through which the practicality of the

proposed system or policy can be drawn. It also offers a potential framework for planning and assessing a proposed development including identifying stakeholders. In general, the stakeholders analysis is considered as a procedural compulsion and not conducted in a systematic way. This resulted in failure of the particular enterprise or business at the very inception stage. Feasibility analysis should consider the technical, economical, operational, scheduled and legal requirements of the project/ policy. Stakeholders' feasibility analysis is the process of collecting and analyzing data prior to the new business start-up, and then using knowledge thus gained to formulate the business plan itself (Castrogiovanni, 1996).

Steps involved in the stakeholders analysis

The stakeholders analysis comprises of planning, defining, identifying, engaging, managing and executing the process or business. There are eight major steps in the stakeholders analysis process. The analysis process requires lot of time to make it successful. It should follow certain steps to conduct the analysis. The process of the stakeholder analysis is presented in fig.2.

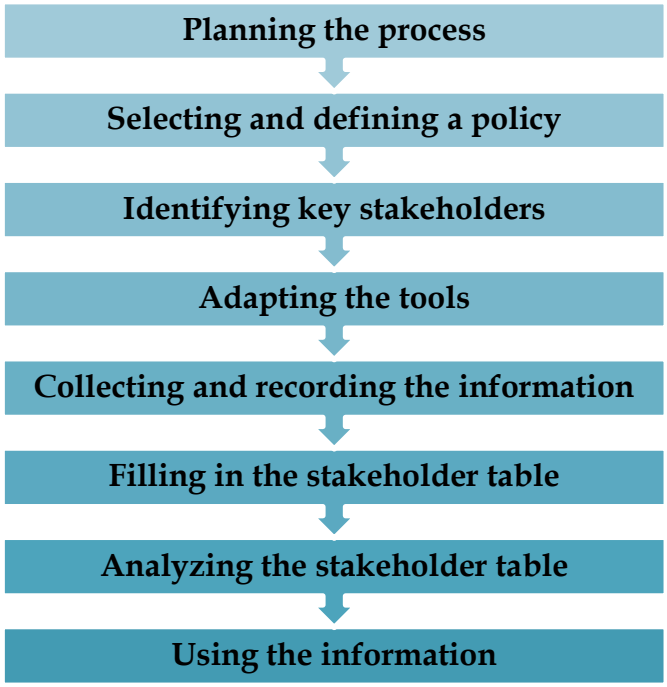

Fig. 2. Steps in the stakeholders analysis

Stakeholder analysis models (SAM)

Stakeholder analysis is based on various attributes. The attributes used in thestakeholder analysis models are power-interest, power-influence, influence-impact, priority-impact, power-legitimacy-urgency. These attributes are the clue for deriving the strategies towards addressing

the concerns and constraints. A common approach is to map the interest and power or influence of each stakeholder group on a quadrant, Stakeholders interest and attitude determines the success and failure of any enterprise. Hence, it is often treated predominant to examine the feasibility of stakeholders' during early stages of enterprise development. The prominent models used in the stakeholder analysis are,

i. Power-Interest grid (level of authority and level of concern)
ii. Power-Influence grid (level of authority and active involvement)
iii. Influence-Impact grid (active involvement and ability to effect changes)
iv. Priority-impact grid (Level of importance and ability to effect changes)
v. Salience model (Power-Legitimacy-Urgency)

i. Power – Interest grid

In this model, the stakeholders analysis is carried out using the two attributes viz., power and interest. The stakeholders with high power and high influence are the key players. The one with low power and interest are considered least important.

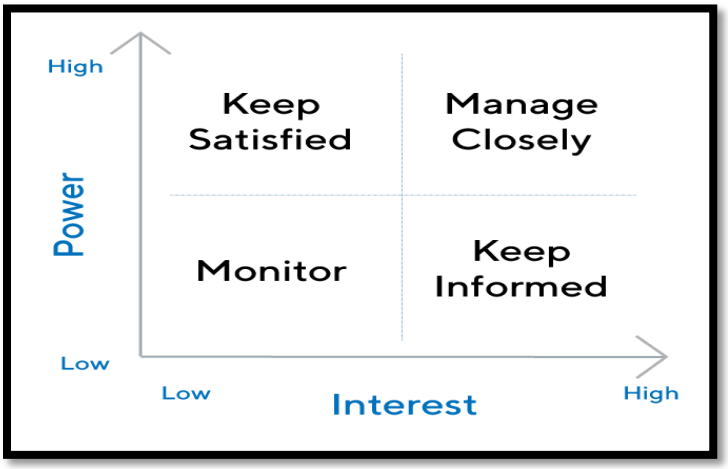

Fig 3. Power – Interest grid

ii. Power-Influence grid

In this model, the stakeholders were classified based on power and influence.

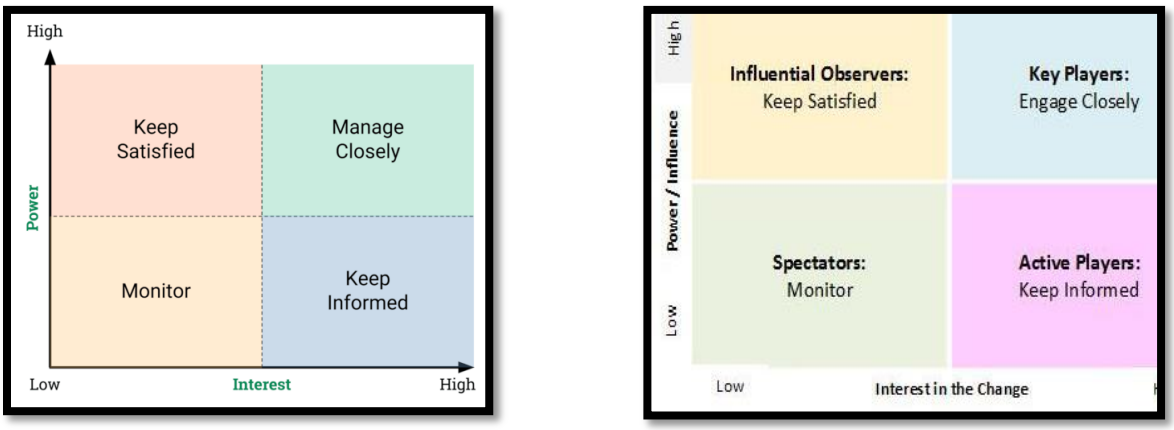

Fig 4. Power – Influence grid

Like, the power-interest grid, this model also uses the same characteristic for categorizing the stakeholders. Based on the level of interest/ influence and power, the stakeholders are classified into key players, active players, observers and spectators.

iii. Influence- Impact grid

This model explains the relationship between influence and impact of the stakeholders. The stakeholders are classified based on the level of importance ranged between high and low. The grid is as similar to the previous two models.

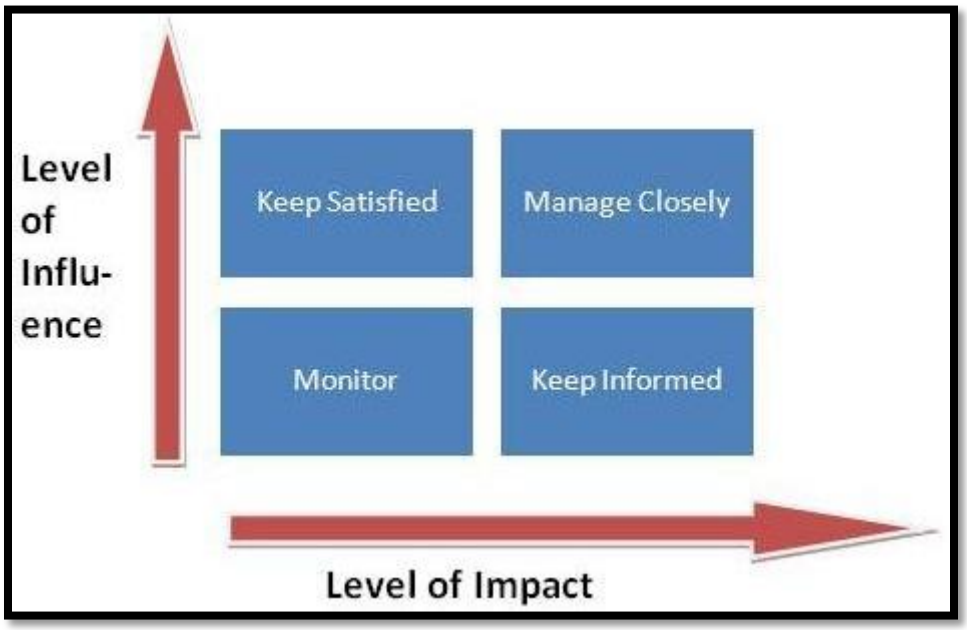

Fig 5. Influence – Impact grid

The above three models are explained by the mendolow framework using the three attributes of power, interest and influence. According to Mendelow,power, interest and influence are defined as follows.

- **Power:** Power is the stakeholder's ability to influence objectives
- **Interest:**Interest is how much the stakeholders care
- **Influence:**Influence is the product of power and interest i.e., Power x Interest

iv. Priority-Impact model

Priority is the combination of impact and urgency**.** This model is significant in analyzing the stakeholders in connection with the policy reform. The stakeholderslevel of priority and impact on the implementation determines the success of policy. Based on the level of priority and impact the stakeholders are grouped into promoters, defenders, latents and apathetic (Table. 1).

- **Promoters:** Stakeholders who attach a high priority to the reform policy a priority and whose actions can have an impact on the implementation of the policy.
- **Defenders:** Stakeholders who attach a high priority to the reform policy but whose actions cannot have an impact on the implementation of the policy.

Table 1.Stakeholders position in Priority-Impact model

Stakeholder classification	Priority	Impact	Position
Promoters	High	High	High – High
Defenders	High	low	High – Low
Latents	Low	High	Low – High
Apathetics	Low	Low	Low – Low

- **Latents:** Stakeholders whose actions can affect the implementation of the reform policy but who attach a low priority to this policy.
-
- **Apathetics:** Stakeholders whose actions cannot affect the implementation of the reform policy and who attach a low priority to this policy.

The above four models are based on the two dimensional attributes towards analyzing the stakeholders analysis.

v. Salience model

Salience model is a systematic model used in determination of stakeholders towards managing them effectively. According to the Salience model, non-stakeholders are those who are not holding any attribute at the particular point of time.

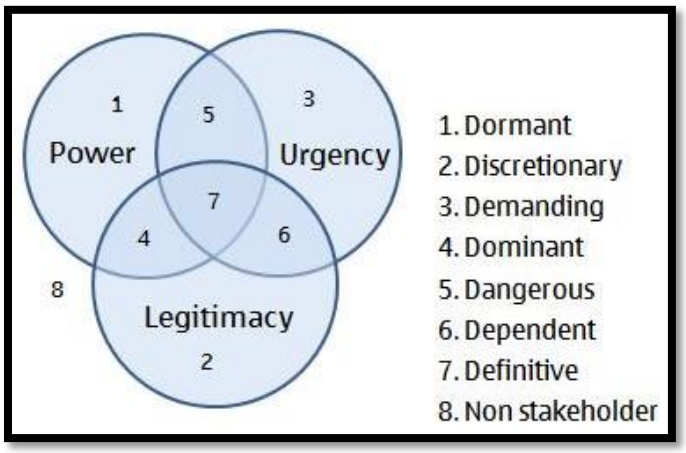

Fig. 6.Classification of stakeholders – Salience model

Power is the 'extent of which one can gain access through coercive and normative means'. Legitimacy is that 'action is desirable within the prevailing social system' and Urgency extents 'the degree of which the stakeholders require attention'. The stakeholders holding any one of the attributes are determined as dormant (power only), discretionary (legitimacy only) and demanding (urgency only). There were classified as latent stakeholders. Similarly, stakeholders holding any two of the attributes were classified as dominant (power and legitimacy), dangerous (power and urgency) and dependent (legitimacy and urgency). These three stakeholders were categorized into broad category called expectant stakeholders.

The stakeholders who are holding all the three attributes and influence the business start up are classified as definitive stakeholders. Those who are not holding any attributes are known as disinterested stakeholders. The stakeholders' determination matrix shows the degree of interest of stakeholders and their capacity to support the fish based enterprise at the selected locality in the long run (Table 2).

Table 2.

STATUS	POWER	LEGITIMACY	URGENCY	TYPOLOGY
Latent Stakeholders				Dormant stakeholder
				Discretionary stakeholder
				Demanding stakeholder

Expectant Stakeholders	■	■		Dominant stakeholder
	■		■	Dangerous stakeholder
		■	■	Dependent stakeholder
Definitive Stakeholders	■	■	■	Definitive stakeholder
	■	■	■	Definitive stakeholder
	■	■	■	Definitive stakeholder
	■	■	■	Definitive stakeholder

Goals of Stakeholder Analysis

The main goals are to maintain or increase power of stakeholders through building coalitions, and providing information and resources, convert opposition into support through negotiations, information and/or coalition building, including offering tradeoffs and also to offset or counter powerful and not so powerful opponents. Some of the stakeholders and their positions may change over the course of negotiations and analyses. Hence, these should remain an ongoing process allowing for policy design to adjust as more is known about the political reality.

Policies on stakeholders analysis

Policies towards stakeholders analysis should consider the following approaches for ensuring effective stakeholder management.

- Stakeholders' feasibility analysis should be conducted at the pre-business stage or early stage of development (Early starting up)
- The analysis should be conducted in a systematic manner (Systematic approach)
- It should involve all sort of stakeholders based on the nature of activities (Multi stakeholders approach)
- It should focus on participatory mode of stakeholders involvement in decision making (Participatory approach)
- It should serve the purpose involving the historical, geopolitical and social-cultural aspects of the particular region (Integrated approach)
- It should not be happened as a procedure formalities rather to be problem solving (Problem solving)
- It should serve the common purpose and common goals of society but not on individual motives (Public policy orientation)

Stakeholders analysis is the starting point and strategic decision making tool for any of the research or enterprise development which requires maximum attention since planning with the involvement of all the stakeholders effectively.

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Comparative analysis of traditional and modernised fishmeal units in Veraval, Gujarat

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Introduction

Fish meal is an important seafood by-product that is used by the poultry, aqua feed and agricultural sectors. Trash fish catch is the major source of raw material for the fish meal plants. Apart from this the waste generated from fish processing factories and dry fish is also used as raw material (Ponnusamy*et al*., 2012). In aquaculture, fish meal is one of the major inputs for feed production. Quality of fish meal is determined by content of its crude protein. Internationally marketed fish meal has a crude protein content of 65% and it varies from 57 to 77% (Sen*et al.*, 2003) based on the raw material used for fish meal production. The international price of the fish meal varies depending on seasonal variation in supply of fish both in terms of quantity and species. Price of fish meal in India is more or less stable throughout the year. In the past two years, it has been observed that the fish meal prices varied from ` 80 to 120 per kg. Along with the traditional sun dried product, a recent development has been the production of modern fish meal in modern fish meal plants. In these modern units, through a mechanised production line, raw fish is cooked, dried and finally ground to produce fish meal. But, the quality and price of the modern fish meal is better than the traditional sundried fish meal and has fine texture and uniformity. Because of modern protein content, lesser moisture (7-8%) and sand silica (0.5-2 %) it preferred more for export market. Hence, there is increasing demand for setting up modern fish meal plants using machinery like steam boilers, dryer, coolant, grinder cum pulveriser and packing.

Unlike other states, in Gujarat, the type of fish meal produced is different and it is made predominantly from the processing waste and the oil content is less, which is also attributed to the non-availability of oil sardine in the Gujarat coast. Hence the fish oil is not produced as a byproduct in these units and therefore, income of each unit is entirely based on the single product *i.e.* fish meal powder. This paper presents a comparison of economic viability of both traditional and modern fish meal units operated in Veraval in Gujarat State

Materials and methods

The study was undertaken in and around Veraval, Gujarat State during the year 2014-15. Totally, 12 fish meal units were selected for the study covering eight traditional and four modernised fishmeal units. A semi-structured interview schedule was used for data collection. The data related to operation of fish meal units were collected from both the units.

The investment decisions were made for starting any production unit, using the discounted cash flow (DCF) decision-rules. Among the decision-rules, the most well-known are the net

present value (NPV) criterion, the internal rate of return (IRR) and benefit/cost ratio (BCR) equations, which are given below, assuming the cost of capital at 15% for calculating the discounted cash flows.

***Net present value (NPV)*:** NPV is calculated as the difference between the discounted present

$$\text{NPV} = \text{PV (Benefits)} - \text{PV (Costs)}.$$

value of future benefits and the discounted present value of future costs.

Benefit/cost ratio (BCR):Instead of calculating the NPV by subtracting the PV of costs from the PV of benefits, we divide PV of benefits by the PV of costs.

$$\text{BCR} = \frac{\text{PV (Benefit)}}{\text{PV (Costs)}}$$

Internal rate of return (IRR):The discount rate at which the NPV becomes "0" is called the

$$\text{IRR} = \left\{\begin{matrix}\text{lower}\\ \text{discount}\\ \text{rate}\end{matrix}\right\} + \left\{\begin{matrix}\text{difference between}\\ \text{the two discount}\\ \text{rates}\end{matrix}\right\} \times \left\{\frac{\text{NPV at the lower discount rate}}{\text{sum of the absolute values of the NPVs}}\right\}$$

Internal Rate of Return (IRR), which is calculated as:

Break-even point: The break-even point for a product is the point where total revenue received equals the total costs associated with the sale of the product. A break-even point is typically calculated to determine if it would be profitable to sell a proposed product, as opposed to attempting to modify an existing product so that it can be made lucrative. For calculating break-even quantity in this study, one product model is considered (Sathiadhas*et al*., 2009). The total cost of producing a product can be given by:

where,

$$BEP = \frac{TC}{p - v}$$

BEP = Break-even point

TC = Total fixed cost

p = Selling price per unit of fish meal production

v = Variable cost per unit fish meal production

Sensitivity analysis

The market 'cost and price' situation always tend to fluctuate based on the demand and supply of the particular product. From the investor point of view, it is important to study the economic viability of the fishmeal units so that it is highly useful to formulate future strategies and investment decision under uncertain market situation. Sensitivity analysis was carried out by making a small percentage change in existing situation of cost and return. For that, different combinations of incremental costs and returns combinations were used to estimate the respective economic viability criteria *i.e.,* benefit-cost (B-C) ratio, net present value (NPV) and internal rate of return (IRR), which were worked out at 15% discount rate.

Results and discussion

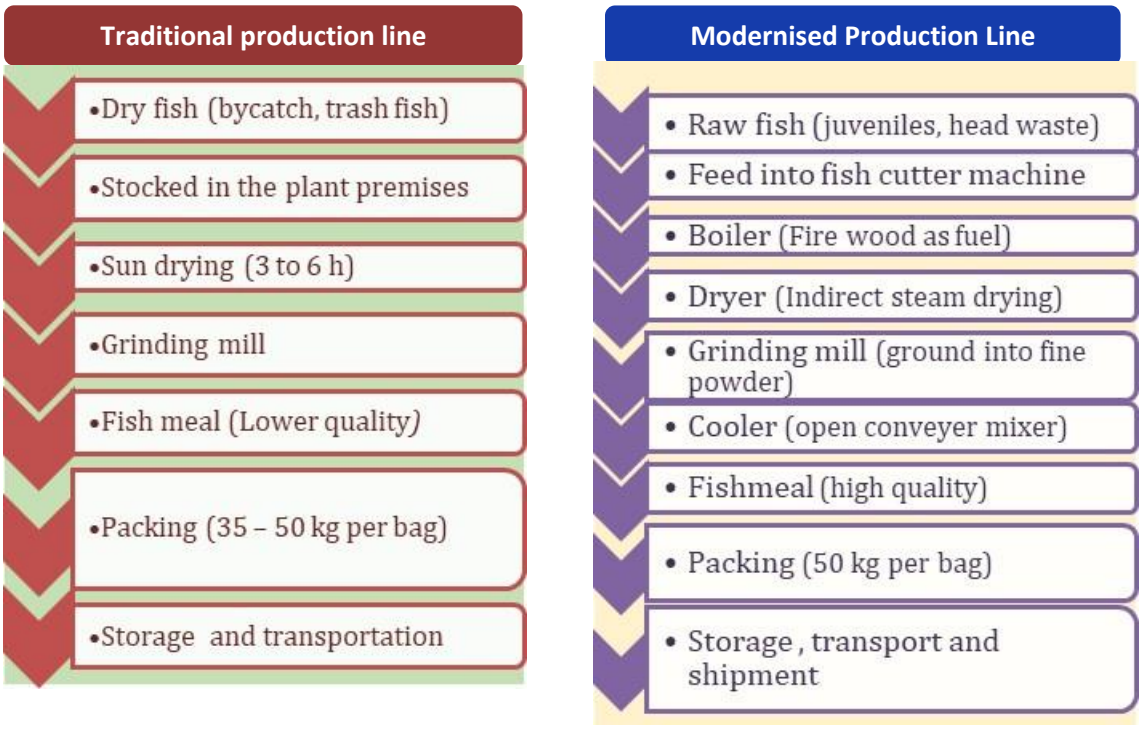
The bycatch (trash fish) mainly from trawlers and waste generated from fish processing plants are the source of raw material for fish meal production in Veraval. Almost 66% of the fish meal units operating in Veraval were found to follow traditional method of fish meal production and the rest of the units were directly producing fish meal using the modern method without extraction of fish oil. Unlike other states producing fish meal, oil sardine is not used as raw material for fish meal here due to non-availability of the same in Gujarat coast. In addition to catfish, other species like lizard fish, dhoma, barracuda, threadfin bream and ribbon fish are used for preparing fish meal. Suguna Poultry Industries fin Tamil Nadu was the major buyer of fish meal from Gujarat.

There are 12 fish meal plants operating in Veraval, out of which four are using the modern method of production. Predominantly, fish meal in Veraval is prepared by sun drying the fishes up to 12-16% moisture level and then going for direct grinding. In this traditional method, dried fish like lizard fish, dhoma, barracuda, head part of catfish, thread fin bream, ribbon fish, trash fishes and jawala (juvenile shrimp) are procured from Veraval and nearby places within Gujarat like Navibandar, Jafrabad, Rajpara, Vanakbara, Okha, Mangrol, Veraval which is sun dried for 3 to 6 h based on the moisture content and then ground to produce fish meal. These traditional types of fish meal are of lower quality and mainly purchased by domestic poultry industries (Palod et al., 1996)

The traditional and modernised production line flow charts for fish meal unit in Veraval are given in Fig. 1. On comparing the two, the investment is higher in the modern units for machineries like raw fish cutting machine, boiler, dryer, cooler, grinder cum pulveriser and conveyor. This investment on machinery is required for improvement of the quality of fish meal produced. The major quality parameters taken into consideration for pricing fish meal are the percentage composition of protein, moisture, sand silica and salt content. The quality comparison between the sun dried and modern fish meal in terms of protein, moisture, sand silica and salt

percentage are given in Table 1. Modern fish meal is comparatively clean and of better quality than traditionally produced fish meal. The traditional sundried fish meal is mostly purchased by the domestic poultry industry, whereas the modern one is sourced mainly by an aquafeed manufacturers for both domestic as well as international market.

Table. 1. Traditional and modernised production lines of fish meal units in Veraval



The purchasing price of raw fishes used for modern fish meal plant varies from `.5 to 10 per kg (Table 2) which is dependent upon the season and availability of fish. The traditional fish meal units purchase raw material in both dry as well as wet form based on the availability. The price of dry fish varies from `15 to 25 per kg while the price of raw fish varies from `4 to 5 per kg. About 90% of fish comes from Navabandar, Jaffrabad and Rajpara, of which 80% is contributed by jawala (tiny shrimp) and the rest by lizard fish *(Sauridatumbil),*dhoma (croaker), barracuda *(Sphyraenajello),*head of catfish, threadfin bream, ribbon fish and trash fishes. Recovery of fish meal in modern fish meal plant is 15-20%, whereas, in traditional fish meal plants recovery percentage is 22.5%.

Particulars	Sun dried fish meal	Modern fish meal
No of fish meal units	8	4
Fish species used as raw material	Dried Juvenile fishes and cutting waste of Jawala, Croaker, Ribbon fish and crab waste	Processing waste (catfish, ribbon fish, leather jacket, thread fin bream)
Cost of fish (` kg^{-1})	4 - 5	5 - 10
Machines	Cutting machine (50HP)	Cutter, Boiler, Dryer, Cooler, Grinder.

Investment particulars	Amount (lakhs)
Boiler	20.00
Dryer	50.00
Cooler	4.00
Grinder cum pulveriser (50HP)	4.00
Packing machine	0.10
Weighing balance	0.80
Chimney 24 x 85ft	1.00
50HP motor (2 nos.)	0.80
5 HP motor (7 nos.)	0.84
Grinder (50 HP motor)	2.00
Conveyer	2.00
Total machinery	85.54

Price of fish meal (` kg^{-1})	20 - 30	50 – 70

Table 2. General particulars of both sun dried and modern fish meal units in Veraval

Investment cost on machinery

The investment particulars for modern fish meal production unit in Veraval are given in Table 3.The installed capacity is about of 50-100 t per day, but on an average, these are operating at 10-20 t per day for 8 to 9 months based on the availability of fish. The total investment on machinery is about `85.5 lakh, out of which, dryer machine itself accounts for 55% of the cost while the boiler (`20 lakh) and dryer together accounts for 78% of investment.

Table 3. Average investment in modern fish meal production unit

Table 4. Average annual cost and return comparison of both traditional and modern fish meal plants in Veraval (Processing 20 t fish per day) (`. in lakhs)

Particulars (per annum)	Cost and returns (`in lakhs)	
	Traditional fish meal unit	Modern fish meal unit
Investment		
Buildings and other structures	50.00	60.00
Machinery including boiler	4.00	100.00
Fixed cost	54.00	160.00
Depreciation	1.73	4.80
Interest on fixed capital	5.40	16.00
Costs of management	1.50	1.80
Insurance	0.10	1.00
Total fixed cost	8.73	23.60
Variable costs		
Cost of fish	160.00	260.00
Labour	14.00	8.00
Electricity	2.20	12.65
Fire wood	0.00	21.60
Lab testing fees	0.00	0.20
Interest on working capital	18.00	30.00
Total operational cost	*194.00*	*333.00*
Total cost	203.00	356.00
Returns		
Returns fishmeal (*TFMU 900 t @ `25 $kg^{-1}$) (#MFMU 720 t @ ` 58 kg^{-1})	225.00	417.60
Fish waste	2.00	0.00
Gross revenue	227.00	417.60
Annual net profit	24.00	61.00
Benefit cost ratio (BCR)	1.12	1.17
Net present value (NPV)	74.00	161.00
Internal rate of return (IRR)	44.00	37.00

*TFMU - Traditional fish meal unit

#MFMU - Modern fish meal unit

Table 4 represents the annual cost and return comparison of both traditional and modern fish meal plants in Veraval with processing capacity of about 20 t per day of raw material in wet form. However, in other states like Karnataka, Kerala and Tamil Nadu, the modern fish meal units have operational capacity of about 100 t per day (Aswathy*et al*., 2013). As per the survey in and around Veraval, the fish meal units operate with less than 20 t capacity of raw material in wet form, which is more profitable in both traditional and modern methods. The conversion percentage from raw fish to fish meal is more in traditional method (22.5%) as compared to modern fishmeal units (18%). This may be due to the poor quality resulting from higher content of sand silica and moisture. The annual return is worked out for 200 days at an average price rate of `25 and 58 per kg of fish meal from traditional and modern fish meal units, respectively. The machinery used in the traditional units is only a single grinding machine, whereas modern units are fully equipped with machinery right from raw material receiving to final product. On comparison, the initial investment on modern fish meal unit is three times higher than the traditional units. The internal rate of return was 44 and 37% for traditional and modern units indicating that both traditional as well as modern fish meal units are feasible. The benefit-cost ratio and net present value are also acceptable, but the values for traditional units were lower than that of the modern units as more labour is used in traditional fish meal units.

Decision making model for fish meal unit

In the analysis, the average cost of financing to start a fish meal unit was taken as 15% per annum. Represented graphically (Fig. 2), the area greater than 15% discount rate will be accepted for finance and less than 15% discount rate is not suitable for investing for both the projects. Using the IRR decision rule, it would appear that traditional fish meal unit is preferable to modern unit given that the IRR is 44% for traditional unit, as opposed to 37% for modern fish meal unit. However, if the NPV decision-rule is used by discounting the future net benefits of each investment at 15%, the NPV is `105 lakh for traditional and `238 lakh for modern units, which is higher. Based on the NPV decision-rule, naturally modern units are preferred than traditional ones. At the switching point, the NPV curves of the two projects cross over at 33%. In other words, at a discount rate of 33%, the NPV of traditional is equal to the NPV of modern fish meal unit. At all discount rates below 33%, the NPV of modern fish meal unit is greater than the NPV of traditional units and at all discount rates above 33%, the NPV of modern unit is less than

the NPV of traditional unit.

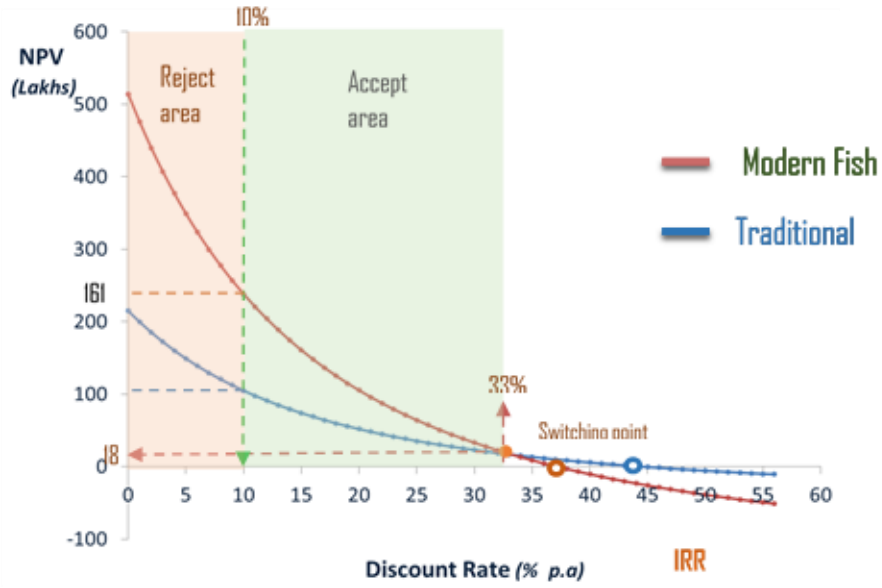


Fig. 2. Decision making graph using NPV of the two different fish meal production methods

Break-even point analysis

The break-even quantity of fish meal produced by both traditional and modern methods was calculated with existing cost and market price situation during the study period (2014-15). The study revealed that the traditional type of fish meal producer present in Veraval has to produce at least 1.26 t of fish meal per day, otherwise annually on an average, it has to operate for 200 days to produce fish meal of 252 t for getting a no profit no loss condition as shown in the Fig. 3. The quantity above 252 t will generate profit. Similarly for modern fish meal unit, break-even point is calculated as 1 t per day or 200 t per annum, as is indicated in the Fig. 4.

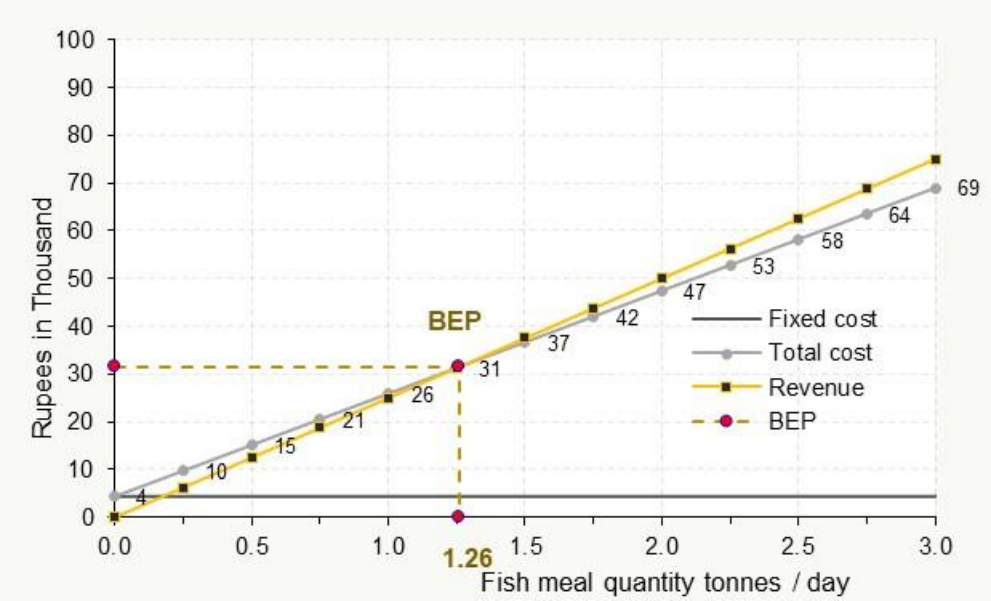


Fig. 3. Break-even quantity of traditional fish meal (t day^{-1})

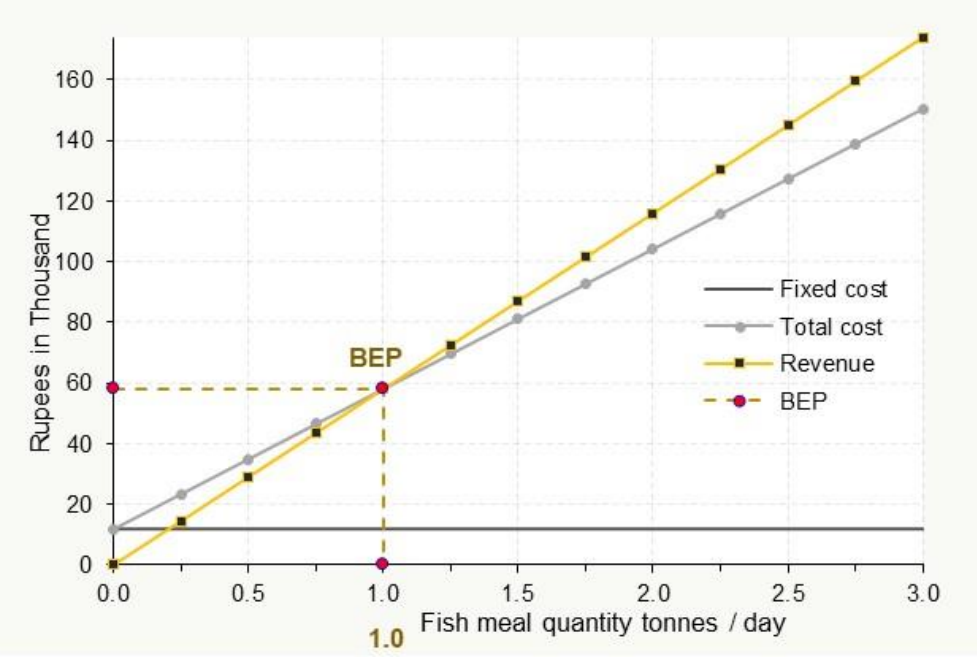


Fig. 4. Break-even quantity of modern fish meal (t day^{-1})

Economic viability fish meal unit - using sensitivity analysis

The annual cost and return for traditional fish meal unit operating at 20 t capacity of raw fish is `.203 and 227 lakh, respectively. Similarly for the modern fish meal unit, annual cost and return were `356 and .417 lakhs, respectively. Additional cost and return for both the fish meal units were analysed with change in cost and return of 0, 5 and 10% for both positive and negative combination. The positive symbol indicates the increase of percentage change in cost and benefit and *vice-versa*.

Table 5. Economic viability of the traditional and modern fish meal unit and sensitivity analysis

% Change in cost	% Change in benefit	Traditional unit			Modern unit		
		BCR	NPV	IRR %	BCR	NPV	IRR %
0	0	1.12	74	44	1.17	161	37
0	-5	1.06	12	20	1.12	55	23
-5	0	1.18	125	63	1.24	258	49
0	+5	1.17	131	65	1.23	274	51
+5	0	1.06	18	23	1.12	71	25
+10	0	1.02	-35	-4	1.07	-22	12
0	+10	1.23	190	86	1.29	383	65
0	-10	1.01	-47	-17	1.06	-54	6
-10	0	1.24	178	82	1.30	351	61
-5	+10	1.29	244	105	1.36	476	76
+10	-5	0.97	-94	(-ve)	1.01	-131	-13
-10	+5	1.30	237	103	1.37	460	74
+5	-10	0.96	-100	(-ve)	1.01	-147	-22
-5	-10	1.06	6	18	1.11	39	21
+5	+10	1.17	137	67	1.23	290	53

The sensitivity analysis at different combination of cost and price condition of both traditional and modern fish meal units is presented in Table 5. It shows that the B-C ratio is greater than one for all combinations in modern unit and the occurrence of positive NPV, except wherever 10% incremental costs and 10% decrease in benefits were showing negative net present value. Similarly, for traditional fish meal unit where B-C ratio, NPV and IRR show negative value at 10% incremental cost and 10% reduction in benefit levels. This indicates that both types of fish meal units will not remain economically viable under this scenario, if percentage change in cost goes higher. As a whole, the analysis indicates higher rate of return on capital invested compared to the opportunity cost of capital at 15% (rate at which banks are generally extending long-term loan) and thereby, confirming the economic viability of the both traditional as well as modern units.

Evaluation of the products shows that the quality of the fish meal produced in the modernised units is superior. While sun dried fish meal fetches `20-30 $kg^{-1}$, the fish meal produced in modern units is sold at `55-70 kg^{-1}. Even though the initial investment and operational cost, which includes raw material, labour and other overheads is more in the modern method, the price realisation (NPV) is almost double per kg and quality of the fish meal is also better than traditional one. The benefit-cost ratio and net present value for modern method were also higher. Based on the sensitivity analysis, 10% increase in costs or 10% decrease in benefits showed negative net present value.

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Streamlining Fisheries Extension

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Introduction

The fishery sector is increasingly recognised as a sunshine sector as it contributes immensely not only to the foreign exchange reserves and GDP, but also to the food and nutritional security. More important is the livelihood security of the 15 million people depending on the sector. But, the sector faces a number of challenges. The major issues are overexploitation of the resources and consequent decline in catch, upsurge in cost of fishing, climate change and vulnerability issues, low yield from inland resources etc. (Kurien, 1991; Kurien and Achari, 1994; Devaraj and Vivekanandan, 1999). In the recent years, aquaculture and inland sectors has outgrown the stagnated marine sector and contribute 65 % in 11.41 million tonnes in 2016-17.Given the extensive river and canal system of about 195 thousand km, consisting of 14 major rivers, 44 medium rivers and numerous small rivers and streams, in addition to the pond and tank resources of at 2.36 million ha, inland sector including aquaculture to remain as the major sources of growth in Indian fisheries sector. The recent evidences suggest an increasing role of inland sector, both as a share and in growth performance (Suresh and Sajesh, 2017). A significant issue is the impact of climate change and the adaptation to it. The coastal population is vulnerable to climate change and reduced fish catch remains a major challenge to the livelihood security. Further, fishing operations contribute to the climate change due to increased emission of greenhouse gases. For every tonne of fish caught, the CO2 emission has increased from 0.50 tonnes to 1.02 tonnes during 1961 to 2010 (Vivekanadan et al., 2013).The fisheries sector has to respond to these challeneges, so as to achieve the envisaged sustainable development targets.

In order to consolidate the gains and to mitigate the emerging challenges, a strong extension system should be there in place. Extension provides the information and services needed and demanded by farmers and other actors in rural settings through different activities to assist them in developing their own technical, organisational, and management skills and practices so as to improve their livelihoods and well-being. Fisheries extension envelops the fisheries development in action (Ananth, 2010). Cole (1977) has opined that that fisheries extension services is mainly intended to achieve all-round development of the fishing sector. Wang(2001) have noted that effective extension services have contributed to increased aquaculture production.

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Further it could support the economic development and wellbeing of aqua farmers. In India, though both the central and state governments formulate policy guidelines, the states have the major role in executing the extension programs at field levels through their respective Departments of Fisheries (DoFs). The Union government also provides financial support through its schemes to provide technical, financial and extension support to aqua farmers (Kumaran et al., 2002).

Fishing community in India is at the lower rung of the development (Sarkar,2012). It has been pointed out that the low standard of living of fishing communities in southern Asia is

due not only to low productivity caused by primitive production methods and processing technology, but also to the poor socio cultural and economic conditions with which these technologies are incompatible. Extension work includes attempting to change views, beliefs, norms, abolishing social taboos and exploitation, with the aim of improving the standard of living. Tietze (1984) has suggested areas of activities to be undertaken to achieve the goals like welfare of fishermen as well as conservation and efficient exploitation of fishery. Scope of fisheries extension is evolving overtime with the emergence of new challenges, concepts and practices. It encompasses many aspects like entrepreneurship development, disaster management, organizational development etc.

Table 1: Functions of Fisheries Extension Services

Area of Work	**Objectives**
1. Technology transfer	Improved techniques of mariculture and aqua culture Introduction of modern craft and gear material for fishing Scientific post- harvest practices Diversified technology application in fisheries Introduction of innovative technology application methods
2. Information And support services	Information support to fishermen about prices, types and availability of known and new fishing inputs
3. Food safety and quality.	Awareness creation on importance and methods of hygienic handling of fish. Promotion of food safety and quality standards among various stakeholders.

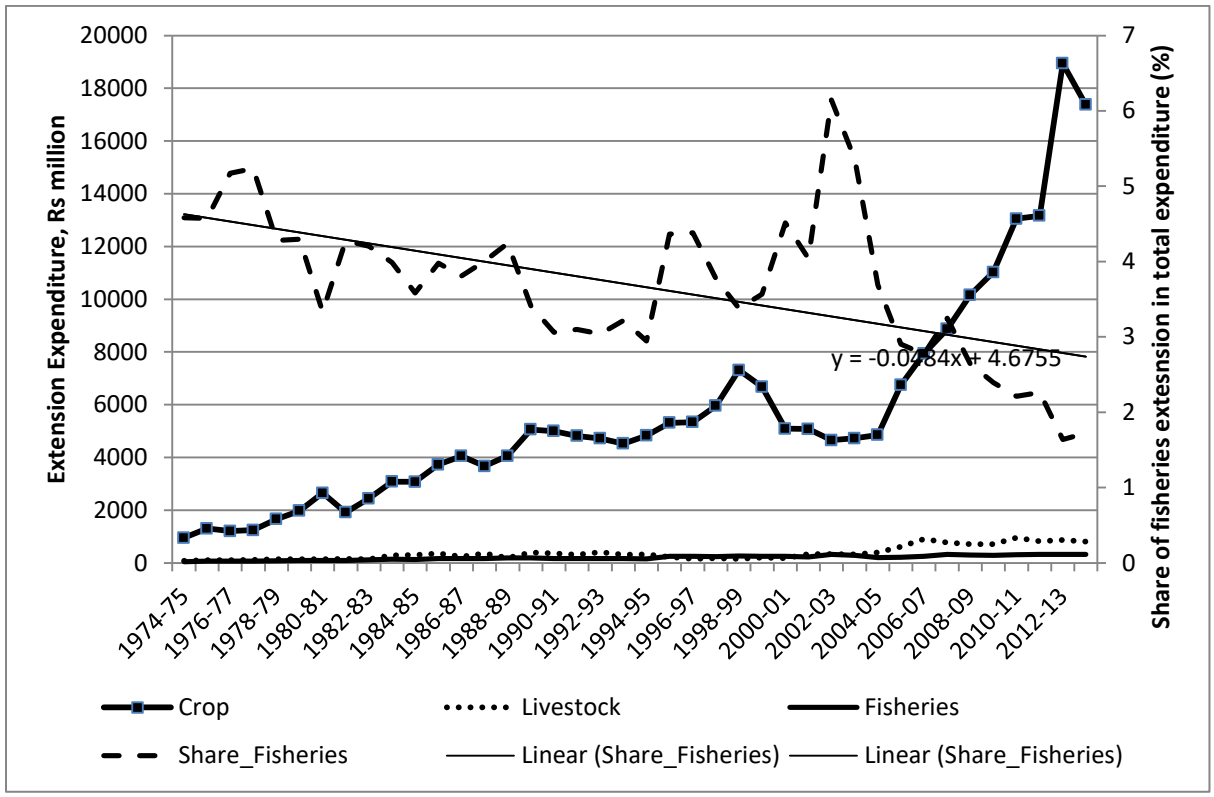
4. Marketing and distribution	Provision of real time marketing information to fishermen about wholesale and retail prices, ultimate market places etc. Strengthening the position of the fishermen against middlemen by organizational and financial support of marketing through fisher women and co-operatives
5. Sustainable fisheries	Advising and educating fishermen in resource conservation methods and responsible fishing practices
6. Credit and finance	Facilitating direct contact between banks and fishermen Facilitating indirect institutional finance through self help groups, co-operatives, credit societies etc. Implementing welfare schemes for the development of poorer fishermen Promotion of institutional savings
7.Organizational and capacity development	Facilitating the development of fishermen organization to promote collective action. Capacity development of various actors in the value chain.
8.Entreprenurship development	Identification and promotion of entrepreneurial possibities in fisheries sector Development of entrepreneurial capacity of students, rural youth , fishermen and women Incubation support to potential entrepreneurs Facilitating technology commercialisation
9. Safety measures	Awareness generation about life saving equipments, risk communication devises and survival strategies. Skill development on use of communication devises and survival techniques
10. New extensionist approaches	Networking, promotion of interagency collaboration, facilitation, creating many-to-many relationships among the wide range of actors.

Though extension has multitude of roles to play spanning from technology dissemination to conveyance of policy goals to major stakeholders, role performance of extension system depends on the policy support with respect to financial outlay and human resource. The paper is an attempt to analyse the policy support to fisheries extension in terms of public expenditure on it.

Indian fisheries sector faces a multitude of issues. Some of the issues are emerging and begs for renewed focus of the extension system. The overexploitation of fish stocks, climate change and its consequence on fish catch and livelihood of the coastal population, quality and food safety concerns, pollution of marine ecosystem, sustainable fishing practices, fish processing and entrepreneurship development are few issues where the extension system has to focus. Further, information on development initiatives and institutional support are to be spread among the clientele. To address these challenges, the research outputs need to be passed on to the farmers, for which an efficient extension system is required. For this development of adequate human resources and institution development, supported with adequate financial outlays are required. The financial supports needs to be in the realm of establishing extension methods, including traditional methods as well was usage of Information and communications techniques (ICTs) and infrastructure development.

The trends in the expenditure on agricultural extension disaggregated across crops, livestock and fisheries are provided in Figure 1. The figure also provides the share of fisheries extension in overall extension expenditure. Trends in expenditure (Centre plus State governments) on fisheries extension from 1974-75 to 2014-15 (Figure 1) pointed out that there is a steady rise in expenditure on fisheries extension except for the reversal during the periods 1990-91 to 1994-95 and 2002-03 to 2004-05. The expenditure on fisheries extension has increased from about Rs 50 million in 1974-75 to Rs 319 million (real price, 2004-05 base) by 2014-15. Though the trend is impressive, at the absolute level, it appears to be quite meagre, considering the vast coast line and emerging trends in aquaculture.

Figure 1: Trend in Expenditure on Extension in India,1974-75 to 2013-14, real price (2004-05 base)



But, while comparing the expenditure on fisheries extension with expenditure on other sectors, especially with expenditure on agricultural extension, huge difference is observed. Further, the difference was found to be getting widened over years. There was large scale expenditure on agricultural extension from 2004-05 on wards owing to the implementation of Agricultural Technology Management Agency Programme. But, there was no commensurate increase in the case of expenditure on fisheries extension or livestock extension. Expenditure on agricultural extension is justifiable as there are around 158 million operational holding to be reached. But, it is also important to enhance the spending on fisheries extension, given the contribution of the fisheries sector to food and nutrition security, employment generation and foreign exchange earnings.

Over the years, the share of fisheries extension in the total extension expenditure was found to be less than 5 per cent except during 2002-03 (6.14%) and 2003-04 (5.35%). Further, there was decrease in the share during recent years as evident from meagre 1.7% during 2013-14. The trend in the share of expenditure on fisheries extension in total extension expenditure points out continuous decline over years with average annual reduction of 0.048 percentages. The findings have serious policy implications, given the potentials of the sector being confronted with deficits in the realm of information, advisory, capacity building and support services.

While the total fish production has increased, it is characterised by an increase in the share of the inland fisheries and a corresponding decline in the marine fisheries. The issues facing in both the

sectors are also different. The aquaculture and inland fisheries constitute close to 60% of total fish production in India, and this share is on increase. The public expenditure towards fisheries extension carries a significant role in it. It is reported that the marine fisheries is facing the issue of sustainability, as there is a decline in the catch due to several factors (NCAP,2004). Various state governments have developed regulations with regard with an aim to ensure sustainable fisheries. For example, Government of Kerala has developed trawl ban in during the monsoon period. Also there are technologies with regard to craft and gear which can help reduce juvenile fish. ICAR- Central Institute of Fisheries Technology, Kochi has developed several technologies including gear with square mesh codend. This technology is proved to address juvenile harvesting. Another important issue is catch of unintended organisms including sea turtles, which are classified as endangered. The Turtle Excluder Devices (TED) developed by ICAR-CIFT is found to be effective in addressing this issue. Usage of energy efficient fishing vessels including solar powered one, post-harvest management of fisheries, safe fish consumption, fish processing, gender issues and entrepreneurship development are the major areas of concern. Another area of concern is safety of fishermen at sea and pollution in marine ecosystem. There are several technologies to boost marine fish production including cage culture which need to be promoted. Reducing the cost of the equipment is a concern for promoting its adoption. It is estimated that cage culture has the potential to produce almost million tonnes in India, so as to address the growing demand for marine fishes.

The management of marine fisheries is complex on account of the property rights issues. Marine fisheries, operates with the common property or open access regime, where the principles and practices applicable to private property regime is not tenable. Strong participation of the community is essential for implementing any kind of regulation, development activity. Awareness generation is an important pre-requisite. Local knowledge, norms and beliefs of the fishermen community has strong linkage with the fishing operation and livelihood. The issues of marine fisheries are not recognised in mainstream agricultural extension system, which serves as the major impediment in the effort to uplift the dependent population from the abject poverty.

On the other hand, inland fisheries faces serious issues with regard to its production managed including pond preparation to marketing and value addition. Feed preparation, application of feed supplements, antibiotics and other chemicals are matter of concern. However, the need for a strong extension system has not received the attention it required.

A disaggregated analysis of the growth in the real expenditure in extension activities reveals that the extension expenditure over years has not registered a consistent growth (Table 2). In fact, during the period between 1995-96 to 2004-05, the real extension expenditure has suffered a negative growth for crop and fisheries sectors resulting in negative growth of overall expenditure. The trend has reversed in last one decade.

Table 2: ***Level and Growth of Extension Expenditure in India, by Sector, 1974-5 to 2013-14*** **in million Rupees and percentage per year**

	Crop	**Livestock**	**Fisheries**	**Total**
Expenditure (Rs.)				
1974-75	949.96	82.61	49.56	1082.14
1994-95	4826.16	320.64	156.17	5302.97
2004-05	4851.2	394.14	200.99	5446.34
2013-14	17378.8	804.61	318.53	18501.94
Growth rate (Percentage per year)				
1974-75to 1994-95	8.7	7.8	6	8.5
1995-96 to 2004-05	-2.6	9.7	-0.05	-1.9
2005-06 to 2014-15	13.2	2.3	4	12.2

In the last one decade (2005-06 to 2013-14), growth rate in extension expenditure (Centre plus State governments) in fisheries sector was found to be 4%. Central government expenditure has shown a slow positive trend (0.94%) during the last decade, while expenditure by states and UTs have shown an increasing trend (2.8%). Growth rate was found to be higher (6.61%), when coastal states considered separately. As already discussed

While the fisheries sector has been exclusively under the state subject, many policies at central level have an influence. This is particularly so in case of marine fisheries in the context of sustainable fisheries. The states differ in their policy and action plans with respect to many guidelines of sustainable marine fisheries, thereby allowing loopholes in the system for circumventing the rules and regulations of any particular state. For example, while the Government of Kerala has been a front runner in implementing policies on juvenile fishing, the fishermen/ boat owners finds safe havens in less regulatory states. Also, central government agencies like MPEDA (Marine Products Export Development Authority) and centrally funded programmes like FFDA (Fish Farmers Development Agency) are involved in extension service delivery. A well coordinated extension agency can have a greater role in implementing the policies more effectively. Real-time information accessibility and effective usage of information

and communication technologies (ICTs) can enhance effectiveness of fisheries extension. There is a need to have coordinated action with other stakeholders including marine enforcement agencies. Lack of research-extension linkage mechanisms has further aggravated capacity enhancement and information dissemination. The Coastal Aquaculture Authority Act (2006) has pointed out the importance of synergy among extension personnel and other stakeholders for achieving the sustainability through interacting their technical expertise and skills.

Currently the human resources employed in the fisheries extension in public sector is quite low, and needs to be enhanced. For example, available information shows that there are around 850 and 734 fisheries extension personnel in Andhra Pradesh and West Bengal respectively, which appears to be inadequate when reckoned against the vast coastline, inland waters and fish production in those states. The state of Kerala has 200 Matsyabhavan officers and 51 matsyafed cluster officers. Qualified extension manpower is required to address the challenges across the value chain in these emerging sectors, which in turn require adequate budgetary provision.

Though fisheries sector is gaining policy level attention due to its potential contribution to national economy, fisheries extension is yet to receive adequate support at policy level through a substantial budget allocation. In Indian context fisheries extension is the weakest link in fisheries development (Rao,1988). Some researchers have argued that agricultural extension principles are applicable for the inland fisheries as the methodologies and practices are linked to land based activities. Extension for marine sector has to be different in nature given the uniqueness and complexity of the sector.

Extension for the crop sector is undergoing transformation over years. The initial top down approach has been replaced and decentralized extension system in many of the states. Agricultural Technology Management Agency (ATMA) has been set up at district levels for the coordination of extension activities in the district. Fisheries extension system is still in nascent stage and reforms are yet to be initiated. Different sub sectors viz. marine, inland, aquaculture etc. have different extension priorities and in turn demands specific mechanism to address those priorities. At present, these issues are remaining neglected. Kumaran *et al*., (2003) have pointed out the need for a committed and properly structured aquaculture extension system in order to propel the growth of the sector. The aquaculture has witnessed an influx of private extension sponsored by companies. A well-coordinated public-private extension system can target specific areas and farmer groups and issues. Further, a strong public extension system is quintessential for service as an alternative source of reliable and verified information and services.

To address the immediate challenges it is important to adapt an innovation system perspective inclusive of all the actors across the value chain. An innovation system can be defined as the network of organizations, enterprises, and individuals focused on bringing new products, new

processes, and new forms of organization into economic use, together with the institutions and policies that affect the system's behavior and performance (World Bank 2006). Research and advisory systems form its core. An innovation system platform like producer collective can facilitate the interaction of research and advisory systems with other actors of innovation system.. Public sector extension agencies have the onus to play the key role in forging such a system. The local self-governance institutions can function as a key link element in such a system, which can address much of the governance issues.

Conclusion

Fisheries sector has emerged as a sunrise sector in Indian economy. The sector has grown consistently well compared to other sectors, and has contributed to the food and nutritional security and provided livelihood for the dependent population. Further, the extension system has to tune with the changes in the fisheries sector. In view of the emergence of inland systems and its continued growth, the public extension system has to step in to address the institutional vacuum. Though India has a thriving fisheries sector, the issues like inefficient resource use, constraints in accessing real-time validated information, non-adherence to rules and regulations, non-judicious use of anti-microbial in aquaculture etc. have been hampering the advancement of the sector. The issues of marine fisheries are on entirely different plane, where the sustainable harvest and ensuring the involvement of the local communities becomes a prime concern. Technologies and policies have to be conveyed to the fishers and fish farmers for sustainably harnessing the resources. The fisheries extension systems are relatively weak in terms of manpower and budgetary allocation, and are inadequate meet the emerging challenges. Adequate policy support in terms of financial support is necessary to reinvigorate the system.

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