Novel extension approaches for extensive dissemination of fish waste management technology

A. K. Mohanty & Rejula K.
Extension, Information and Statistics Division
ICAR-Central Institute of Fisheries Technology, Cochin
dramulyakumar@gmail.com

Fish is one of the most perishable food commodities and it becomes flabby for human consumption within a short span of capture unless it is subjected to some sorts of processing. Presently, post-harvest fish losses (PHFL) have become a major concern, which occur mostly in the fish distribution chains starting from harvesting, transporting, marketing, processing, packaging till consuming which result into an estimated global loss/wastage of 27 percent of landed fish in the process. It has been has estimated that postharvest losses in fishes in developing countries alone shares 50% of their domestic fish production (FAO, 2016). In Africa only, estimates indicate an alarming rate of post-harvest losses with a wide range of variation *i.e.* 20-50 percent. Post-harvest losses in small-scale fisheries are considered as highest of all the commodities in the entire food production system. It is known that substantial losses of fish occur at all stages in the supply chain starting from harvesting to consumption. These losses have a direct impact on fishers, processors, traders and other stakeholders involved in ancillary operations in the sector in reducing their potential income and creating health hazards due to microbiological spoilage. Thus it has a negative implication on food security. Post-harvest fish losses (PHFL) are often caused by enzymatic, oxidative and microbiological spoilage that leads to the quality deterioration of fishes, then it becomes waste which require proper management to convert it into wealth.

Fisheries waste is a major source of surface pollution in coastal areas. Aquatic pollution has become a global concern now-a-days, but even so, most developing nations are still producing huge pollution loads and the trends are expected to increase (Islam & Tanaka, 2004). Fish waste is costly to dispose due to its high organic content (Knuckey*et al.,* 2004). At present, India registers an unparalleled average annual growth rate of 4.8% in fishery that establishes its position as second largest in global fish production of 13.7 million metric tonnes (2018-19) next to China which constitutes 6.5 % of global fish production. A minimum of 4 million metric tonnes of fishery waste is being generated every year, even though it is scattered in the domestic and industrial sector (Zynudheen, 2017). The unregulated disposal of seafood solid and liquid wastes creates environmental and social ill effects in the nearby area. One of the major challenges faced by the coastal communities especially in developing countries like India is the negative externalities exerted by the industries on the environment, affecting their livelihood (Abhilash, 2013). Fish and shellfish processors are facing a rise in the cost and difficulty of waste disposal. This is of particular concern in remote areas where alternative uses (e.g. fishmeal) are neither accessible nor economically viable and therefore, cost effective and environmentally-sound solutions for the disposal of these fish wastes need to be explored

(Mazik, *et al.,* 2005). A comprehensive and fine-tuned participatory extension system is required to face this challenging task in a more strategic way.

Management of waste at Seafood industries

The utilization of by-products is an important production opportunity for the seafood industries, as it can potentially generate additional revenue as well as reduce disposal costs for the waste materials. In the past, fish by-products, including waste, were considered to be of low value commodity and used as feed for farmed animals or thrown away as waste materials. In the last two decades, utilization of fish by-products has been gaining momentum as because they can represent a significant additional source of nutrition. Increasingly, the utilization of fish by-products is encouraging business opportunities for the industries, with a growing focus on their handling in a controlled, safe and hygienic way, thereby also reducing waste (FAO, 2016). There are different methods to manage the waste generated from seafood industries for sustainable seafood waste management which are explained below: -

- Segregation of waste materials into solid and liquid waste
- Shell waste for chitin, chitosan production
- Liquid waste management by treating through ETP

Channelizing solid seafood waste for the production of seafood silage-which could be further utilized for organic liquid fertilizer production-livestock feed thus leading to employment generation as a small scale business unit (Abhilash, 2013).

Innovative work done at CIFT, Cochin on fish waste management

The fish wastes utilization technology evolved by ICAR-CIFT helps to eliminate harmful environmental effects and improve quality in fish processing. 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 considered as an excellent raw material for the preparation of high value products including protein foods. Researches 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. 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, which have wide applications in nutraceutical product development due to its biocompatibility, biodegradability, and bioactive properties like antioxidant, antimicrobial, antihypertensive (Suseela Mathew, 2017).

Waste minimization and recycling

Waste minimization and recycling is one of the management strategies which can be applied in industries. It was found that the water consumption was substantially reduced & total water saving was upto 45 % in an anchovy thawing and gutting industry in Adana Turkey which adopted waste minimization and recycling applications. They could save 48,175$ annually due to water and energy saving. This shows that tangible economic gains can be achieved if waste

minimization and recycling applications are successfully realized in seafood processing industry (Alkayaa & Demirerb, 2016).

Fish composting

Composting is one of the low-investment fish waste management option as per a study conducted by Australian Seafood Co-products (ASCo) Fertilizers. (Knuckey*et al.,* 2004). Hydrolyzed fish offal as a stable liquid fish concentrate which blended with rock phosphate and inoculated with bacteria and fungi using advanced composting technology was developed. (Burdon & M. Elliott, 2005).

In an effort to help the Michigan fish processing industry for better solutions to handle fish processing waste materials, it was recommended that fish waste compost can be used as a component of a growing mix that meets a more demanding specification and for which the consumer is accustomed to pay a higher price. Market led extension need to be adopted while going for technology development which integrates agriculture and allied sectors.

- Conducting demonstration for popularizing the fish waste composting as a source of manure among sea food processors, fish fishers, agricultural fishers and farm women is very much essential.
- Encourage fish processors to plan for fish waste management in terms of a sustainable production system.
- Putting fish waste in a form that processors either use or that will bring an additional revenue stream into the business.

Role of extension for fish waste management

Commercialization and income generation from fishery by-products require sincere efforts from researchers, extension scientists and also economists who can devise a professional and profitable business model for each product developed by the institute from different types of fish wastes. ICAR-CIFT has technical collaborations more than 13 organizations comprising of mostly processing industries and also public/govt. sector agencies for chitins production. There is need to prepare a successful business plan for entrepreneurship development in fisheries in 3S module i.e. Stimulatory phase, Supportive phase and Sustenance phase. Sensitization, ideation, incubation, acceleration and seed funding need to be done at the various growth stages of the entrepreneurship development.

Establishing linkage with industries

- There is need to develop working relationships between the seafood industry and fertilizer manufacturers to commercialize the value addition in fish wastes.
- It was acknowledged that if the utilization of fish waste were to be successful on a broad scale, it would require a considerable level of coordination and cooperation, both within the seafood industry supply chain and across a range of different stakeholders.
- Involvement with a range of seafood companies that may have an interest in adding value to the seafood supply chain through production and utilization of fish wastes.

- Develop an agreed structure for the fish waste utilization company that meets the needs of entire supply chain.
- Develop a business plan for a fish waste utilization company that includes a feasibility/economic analysis and a marketing plan (Knuckey *et al.*, 2004)

Following collaborative approach

- Fish waste management requires a concerted assessment and further discussion between all parties.
- There is a need for a collaborative approach between the industry and the regulators with input from scientific, technical and economic expertise (Mazik, *et al.,* 2005).

Increasing awareness on marine pollution

- Since scientific knowledge on marine pollution is patchy, knowledge gaps have been identified as one of the major problems in introducing effective management strategies for its control.

Strategies for Waste Management in Aquaculture

- Sustainable growth of the aquaculture industry requires profitability, economic development, and waste management.
- Waste management decisions must be made on an individual basis due to site characteristics on the farm and within the watershed.
- Although the costs incurred with waste management seems to be high, they are considered as minor compared to the costs of controlling the environment pollution.
- Policy options to address this issue include, cost-sharing, incentives, feed related taxes, education, and water quality testing that would be used to establish total maximum daily loads (TMDL) as cited by Dan Miller and Ken Semmens (2002).

Innovative extension approaches for technology dissemination

Earlier in developing countries, the extension personnel were involved in diffusion of farm technologies generated by public research organizations, mostly disseminated through appropriate mechanism, *viz.,* On Farm Trials (OFT), Front Line Demonstrations (FLD), field visits, fishers' meetings, media use, etc. These process had the conceptual backup from the 'diffusion of innovation' model. But in the last two decades, the paradigm shifts in development pivots to the enhanced concern for future generations to meet their basic needs, accordingly the nature of agricultural technology design and integration is drawing attention of the extension professionals and practitioners across the globe. In India, different models for transfer of farm technology have been tested and also robust extension management approaches have been validated for successful diffusion of technologies. Furthermore, the frontline extension system of the country has been sharpened through more farmer-centric approaches for technology adaptation and dissemination. The extension system in India has been redesigned to move beyond technology and beyond commodity through ensured reciprocal farmer-research-

extension linkages. Farm producers located at far-off and those unreached still suffer from lack of access to appropriate services like credit, inputs, market, extension, technologies etc.

Keeping eye upon this, the World Development Report had focused on restructuring and revamping agricultural extension system as a pivot for realizing the growth potential of fishery sector against the widening demand–supply pressures for ensuring sustainable growth and pro-poor agricultural and economic development. Therefore, farmer's participatory technology development and client's participatory extension approaches emerged as a part of integration of the '*interdependence model*' and the '*innovation systems framework*' that offered more inclusive ways of involving the institution in technology generation, diffusion and use of new knowledge. Extension approaches have been redefined depending upon the components involved for sustainable growth and livelihood security of the fishers for which a conceptual framework has to be developed in response to recognizing and considering different livelihood assets viz., *social, physical, natural, human and financial resources*. Some of the following innovative extension approaches originating from multiple sources must be adopted on trial basis to make technologies more accessible to provide food, nutrition and livelihood security to fishers, which can be replicated in the fishery sector interwoven with numerous issues including increased production with sustained natural resources, growing market demand for processed products having entrepreneurial opportunities, protection and conservation of environment, and even international trade.

An analysis of national extension systems in the Asia and Pacific region by Qatar (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 ICT revolution. Extension systems in many developing countries have undergone a paradigm shift to more farmer-oriented approaches to rural innovation that emphasize the importance of interactive, integrated and multidisciplinary oriented mutual learning between formal and informal knowledge systems (Friederichsen, 2009). Some of the novel extension approaches found to be appropriate for large-scale dissemination of fish waste management technologies to various stakeholders, which were described below:-

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) approach intends 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.

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).

Market led extension 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, fishers are 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.

Digital extension approach

Extension reforms brought a transformation in fishery extension system through introduction of Information and Communication Technologies (ICTs). The ICT-enabled extension system referred to as Digital Extension has the potential for enabling the empowerment of fishing communities by improving their access to information and sharing knowledge with 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 a case 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 technologies, 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, mKissan, etc. along with some mobile based Apps like mKRISHI® Fisheries, riceXpert, Pusa Krishi, Krishikosh, m4agriNEI CIFT Lab Test, CIFTraining etc. launched in India are some of the successful digital intervention for technology dissemination.

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

Conclusion

Vital role of extension in fish waste management mostly emphasizes on commercialization of technologies through public private partnership, commercialization through farmer producer organizations (FPO), implementing through sustainable extension approaches, popularizing through awareness campaigns and grassroots level problem analysis so that policy level changes can be achieved easily.