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Post-harvest losses in the fisheries sector-facts, figures, challenges and strategies

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Abstract
Post-harvest loss in fisheries (PHFL) denotes the loss of harvested fish due to physical, quality and other unavoidable circumstances in the market. Here, the fish is being either discarded or disposed at a relatively inferior price. About 35% of the total harvest from world fisheries are subjected to PFHL annually. The detailed categorization of causes of PHFL include loss in nutritional value, physical damage, quality deterioration, economic/market force losses, loss due to traditional methods of processing, distribution and storage losses and insect contamination. The features that make the Indian fisheries and aquaculture as an important food producing sectors are, that it provides nutritional security, contributes to the agricultural productivity and engages about 14 million people in primary and secondary activities. India faces an annual post-harvest loss of *₹61,000 crores*, which in turn results in huge deficits in the income of fishermen. This could be a probable reason for the sector that is yet to achieve a higher annual growth rate than that recorded in the recent years, which is only 7%. In this paper, we highlight the post-harvest loss relating to value chain-based assessment, economic loss assessment, food security-based assessment and the impact of pandemics. The recognized tools used in the estimation of PHFL are informal fish loss assessment (IFLAM), load tracking method (LT) and questionnaire-based loss assessment (QLAM) method. There should be strategies such as developing standard package of practices, live fish marketing systems and capacity building programmes for fishermen and processors to minimize the PHFL.

Keywords: Post-harvest loss, India, fisheries sector, post-harvest loss assessment, post-harvest loss reduction

Introduction
Fish is an important source of protein, essential fatty acids, vitamins and minerals. The harvest, handling, processing and distribution of fish provide livelihood for millions of people and also provide valuable foreign exchange earnings. In both the industrialized and developing countries, fish is an important and cheaper source of animal protein to local communities (Adewolu and Adeoti, 2010) [2]. Fish is also used as source of other nutrients such as micro-nutrients, minerals, and essential fatty acids mainly in the Low Income Food Deficit Countries (LIFDCs). However, the disadvantage with the fish is that it is highly perishable though it is an inexpensive protein source. Due to this characteristics, the fish suffers 50-60% higher post-harvest losses (PHFL) compared to agricultural commodities. It is also very difficult to estimate the losses in the sector due to its unorganised nature. The PHFL is defined as the quantum/proportion of harvested fish, which is not utilised for the purpose (either discarded/sold for other uses at a lower price) due to 1) physical damage, 2) quality deterioration and 3) market behaviour and dynamics. The general range of the loss is from 30-60% and in some cases, there may be total loss of the harvested fish (100%). The total loss is generally attributed to the low demand/price collapse during abundant fish harvests. There can be losses in quality, as measured both in terms of the price obtained and the nutritional value, as well as in quantity. Reduction in quantity and/or quality is enormous and difficult to estimate in fish and seafood, as it is perishable. The post-harvest fish losses in the maritime states of India are estimated to the tune of ₹15,000 crores (Assocham, 2013) [9]. These losses are generally the result of the unhygienic handling and processing of fish (inadequate preservation and packaging, lack of storage systems and marketing manipulations).

National status

The harvest and post-harvest losses occur through the value chain in various channels of fish catch disposition. India is reported to face an annual PHFL of ₹61,000 crores in both marine and inland fisheries sectors together. The research efforts at the national and regional levels are very limited with the respect to the PHFL. However, there is an attempt made to assess the PHFL at various marketing channels in Inland Fisheries Sector of Andhra Pradesh (Charles *et al.*, 2007) [14]. Another study was a specific seasonal approach where the PHFL was quantified in a traditional fish processing system in India during monsoon season (Ward, 2000) [33]. This was a major assessment conducted through the funding and support from the National Resource Institute, UK. The post-harvest fish losses in the maritime states of country are estimated to the tune of ₹15,000 crores (Assocham, 2013) [9]. These are the major studies conducted at the national level in relating to the PHFL.

International status

In fisheries and aquaculture, about 35% of the global harvest is either lost or discarded every year. Compared to other animal food sources such as meat, PHFL is globally estimated to be two-three times higher because of the perishability and the lack of cold chains. PHFL ranges between 20% and 75% depending on the type of fishery and mode of value chain in developing nations. Ames *et al.* (1991) [6] pointed out that the situations in which these losses happen are different from region to region which makes it harder to judge and evaluate the losses. Different types of PHFL in the fisheries sector was described as physical loss, economic loss and nutritional losses (Ames (1990) [7]; Eyo (2001) [19]). There are two types of physical losses described by Ames *et al.* (1991) [6]. The first one is the complete physical loss, in which the fish catch may spoil and completely become inedible (discards and bycatch from shrimp trawls). The second one can be regarded as loss of material due to inadequate handling and processing. Nearly 5-20 million tonnes of shrimp bycatch were wasted because of the inadequate processing and chilling facilities (Ames *et al.*, 1991) [6]. The landing of fish in masses may cause physical losses due to the lack of landing and processing facilities in harbours and markets (Poulter *et al.*, 1989) [28]. Inadequate handling of fish will result in the disintegration of the fish catch that make it unfit for sale (Ames, 1990) [7]. A database covering the various types of PHFL as per the Natural Resources Institute (NRI), UK contains 450 records of PHFL from 150 sources (Smith *et al*., 1997). Akande and Diei-Ouadi (2010) [4] made an assessment of post-harvest losses in small scale fisheries with investigations in five sub-Saharan African countries.

In dried fish the minimum PHFL reported was about 8% from Gambia (Walker and Evans, 1984) due to blow flies (4%) and beetles (4%). The maximum loss in dried fish due to beetles was about 50% observed in Nigeria (Rollings and Hayward, 1962) and Mali (Duguent *et al.*, 1985) [36]. The maximum loss (22%) due to blow flies in dried fish was observed in Malawi (Walker and Donegan, 1988). Beetles caused about 40% loss in smoke-dried fish in Niger (Bouare, 1986) [12]. Also the development of rancidity in cured fish causes about 50-60% PHFL (Eyo, 2001) [19]. The nutritional losses generally occur due to the inadequate processing/traditional processing practices (Kumolu-Johnson and Abanikanda 2001) [24]. Some reports state that the high temperature smoking (150 °C) (especially in Africa) and also sun drying affect the availability of lysine, methionine, cysteine and vitamin K (Carpenter and Booth, 1973; Kumolu-Johnson and Abanikanda, 2001) [13, 24]. The economic losses imply PHFL of fish in value as the fishermen, processor or vendor have to dispose the fish for low returns (Ames, 1990) [7].

The International PHFL assessment studies also discussed various measures to limit the losses. Clucas (1981, 1982) [15, 16] explained the ways of reducing the PHFL in fish. The simple adjustments in the handling, processing and storage methods can yield significant reductions in PHFL (Bolorunduro *et al*., 2005) [10]. Chilling is an effective way of preserving fresh fish (Akintola and Bakare, 2011) [5]. The ice flakes/crushed ice are applied to chill and preserve the fresh fish for a longer period as the method provides the maximum surface contact with the fish (Kumolu-Johnson and Jimoh, 1997) [25]. In case of dried salted fish, it is found less exposed to pest infestation than dried fish (Khan and Khan, 2002) [23]. Moreover, there is only 9% of loss due to beetles reported in dried and salted fish, an estimated report from Mali (Aref *et al.*, 1965) [8]. Use of optimum dosage of insecticides like *Pirimiphos methyl*, which are safe for food use is really effective in controlling the blow fly attack in dried fish (Khan and Khan, 2002) [23].

Post-Harvest Fish Loss (PHFL)

PHFL causes potential income losses to the major players in the fishing industry such as fishermen, vendors, traders, processors, and also other stakeholders involved in allied activities. This means that either low quality/low volume fish and fish products are available to consumers. There are also negative implications for the food security. PHFL are basically result of the microbiological and biochemical spoilage that follow fish death.

The different modes of PHFL

1. **Time:** Time period between the harvest and final stage or consumption. Even when it is chilled in ice, the spoilage will occur gradually. The quality of processed fish also deteriorates over time.
2. **Temperature variability:** High ambient temperatures such as 20°C create favourable condition for fish spoilage. Low temperatures (≤5°C) slash down the microbial action and hence the spoilage rates. This significantly reduces the PHFL.
3. **Handling:** Poor handling practices such as using unclean fish boxes and baskets, vessels, and equipment; inadequate cleaning of fish; use of dirty water for washing of fish; keeping the fish on unclean surface and physical damage on fish by carelessness will increase the microbial contamination. This will hasten the fish spoilage.
4. The discard of the bycatch at sea due to legal and financial implications (small size and low value realised)
5. The adoption of poor processing methods could yield PHFL in a significant way
6. The infestation of insect, and other grazing animals could also result in PHFL
7. The PHFL will be very high (60-80%), when the market forces act such as pandemic, and abundant fish landings

Types of PHFL

1. Physical type

In physical loss, the fish are discarded accidentally, voluntary or as authorized means. The physical losses can result from illegal fishing, smuggling, infestation from insects, and

contact with birds and animals. After captured by the fishing gear (trawl, gillnet), the fish will be dead in water and starts to spoil before it is being hauled. In tropical countries, small sized fishes such as sardine and anchovy are sun-dried in open air before packaging and disposition. It is noticed that severe spoilage during rainy season will cause the loss. This type of fish loss can also occur during transportation, due to damage of the boat during the voyage and also capsizing due to weather events.

2. Quality wise

In the quality wise PHFL, the consumption quality of fish is affected due to spoilage/physical damage. The fish will fetch a lower price in such circumstances. This is most common mode of PHFL. Operators store their fish and fishery products for long period due to poor transport and inadequate market awareness that cause the quality deterioration in fish awareness. The fish sellers procure the fish in bulk and may not follow proper storage practices. They will try to sell the bulk during the morning hours. However, the consumers prefer to buy the same at the late hours due to reduction in price. This will holistically result in the PHFL due to quality degradation. These losses are mostly observed in the small scale fish markets

3. Market forces

The fish marketing channel is the most unorganized among the product marketing channels available in the world. The rates of fish are not uniform even on the same day of fish sale. Increased fish landings during peak seasons will reduce the price irrespective of its physico-chemical-biological quality. The lack of market intelligence and barriers also hinder the marketing of fish. During such circumstances, the marketing malpractices will lead to price variability and ultimately cause loss to the producer/fishermen. The festival periods, when fish is not consumed (either all species or some specific types), the PHFL will peak due to increase in supply, and reductions in demand and price. Throughout the post-harvest chain starting from harvesting till consumption, physical damage, quality deterioration and market mediated losses occur. This cause highest share in PHFL and loss of income to the fishers among the above three types.

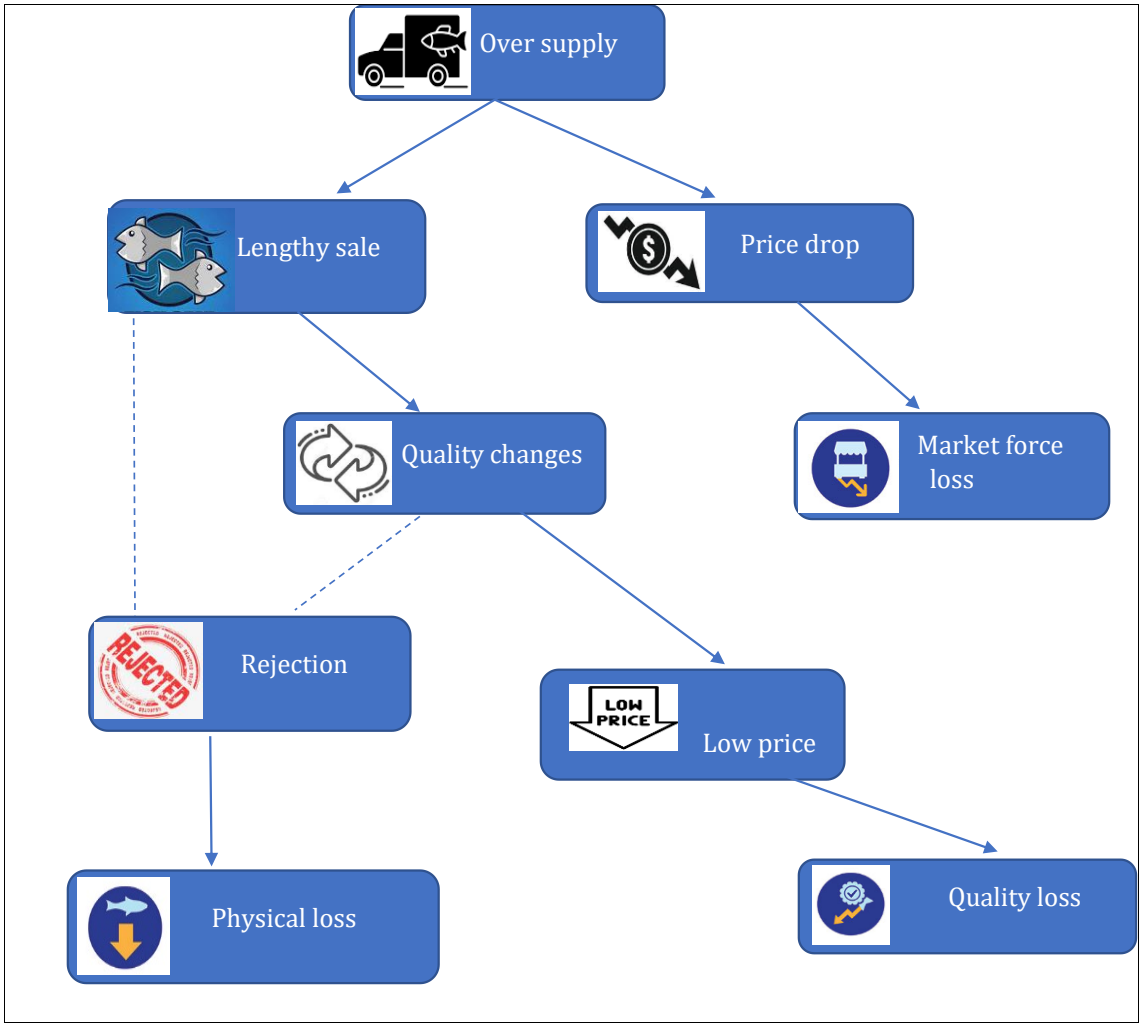


Fig 1: Marketing mediated loss leading quality and physical losses

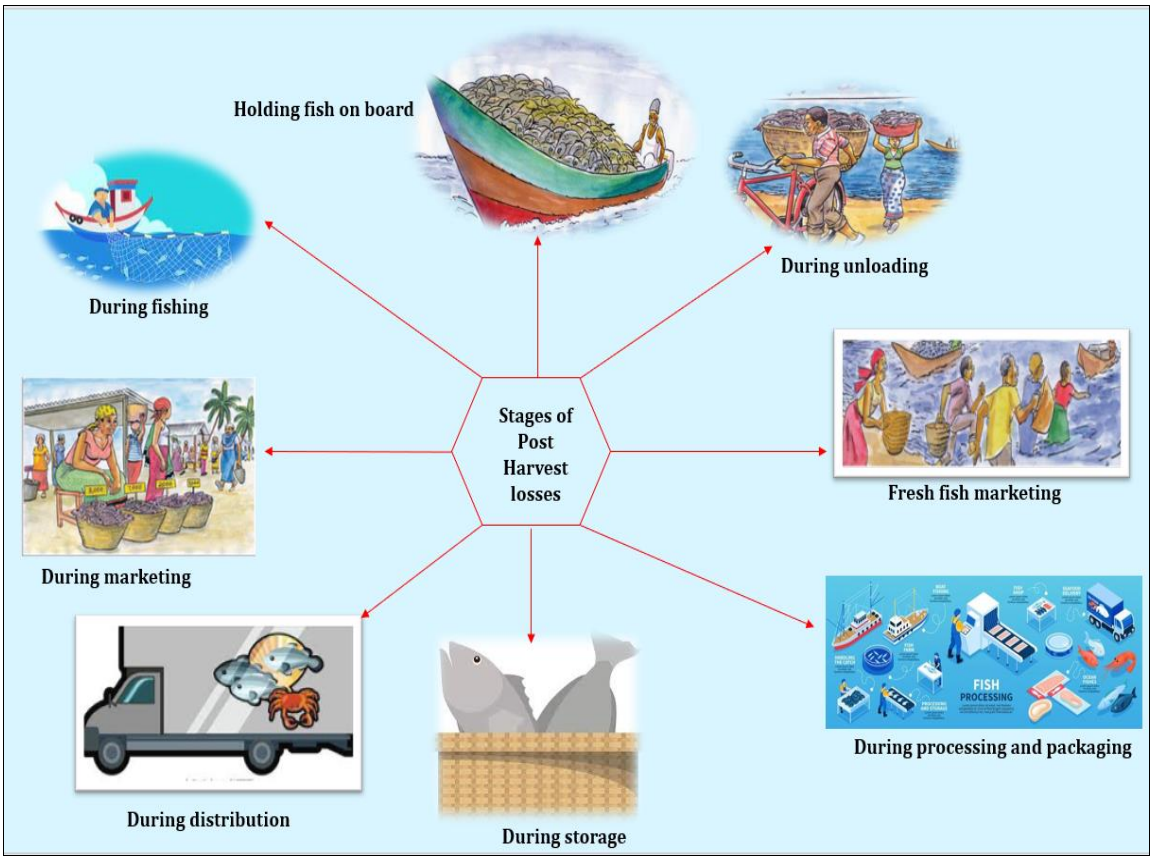


Fig 2: Stages of PHFL

The assessment of PHFL

There are mainly three modes of assessment of PHFL. They are 1) Informal fish loss assessment method (IFLAM), 2) Load tracking (LT) and 3) Questionnaire fish loss assessment method. The IFLAM is a traditional method based on Participatory Rural Appraisal (PRA) principles in the extension research. IFLAM is focuses to develop a general understanding of losses and identify them based on significance. The IFLAM helps the policy makers /fishery managers by generating basic estimates of the PHFL. From IFLAM, LT is designed at specific points of fish marketing for a given geographical area. The kind of PHFL, their shares, and estimates are generated in LT. Both LT and QLAM are quantitative assessment methods. LT is used mainly to quantify the losses during specific processes such as fishing, transport, processing, handling and marketing or at a stage in the value chain. The QLAM is ideally the third step/mode in the evaluation of PHFL after completing IFLAM and LT. The questionnaire based interviews are conducted for a representative sample of the local inhabitants in a specific region, where the PHFL actually reported. This serves as a validation method for the IFLAM and LT. Thus, the PHFL loss assessment protocol should be planned in these three steps, which helps the development of policies for reducing PHFL and assistance programmes to fishermen/farmers. It is also pertinent to note that the impact of PHFL loss interventions will be assessed using the same three-tier protocol (IFLAM-LT-QLAM) followed after the intervention.

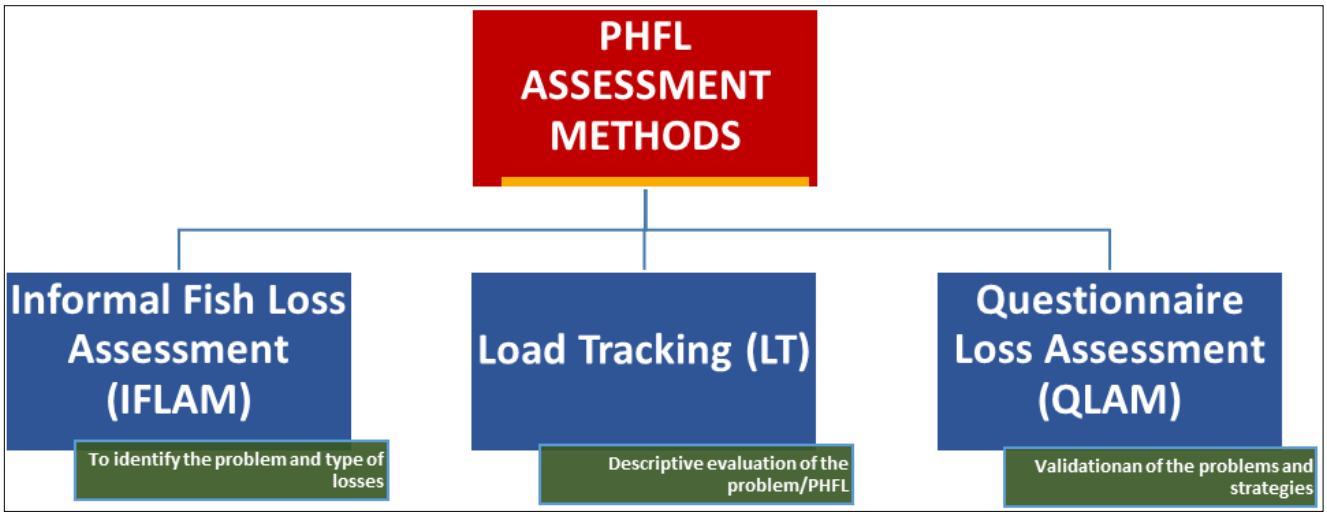


Fig 3: Methods used in the assessment of PHFL

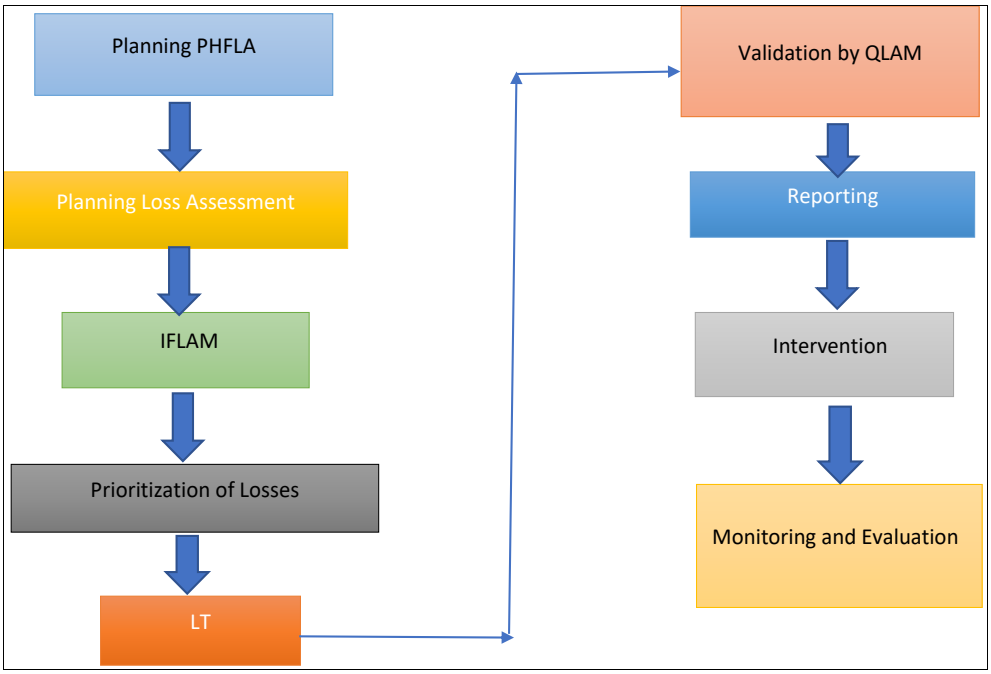


Fig 4: PHFLA planning and execution

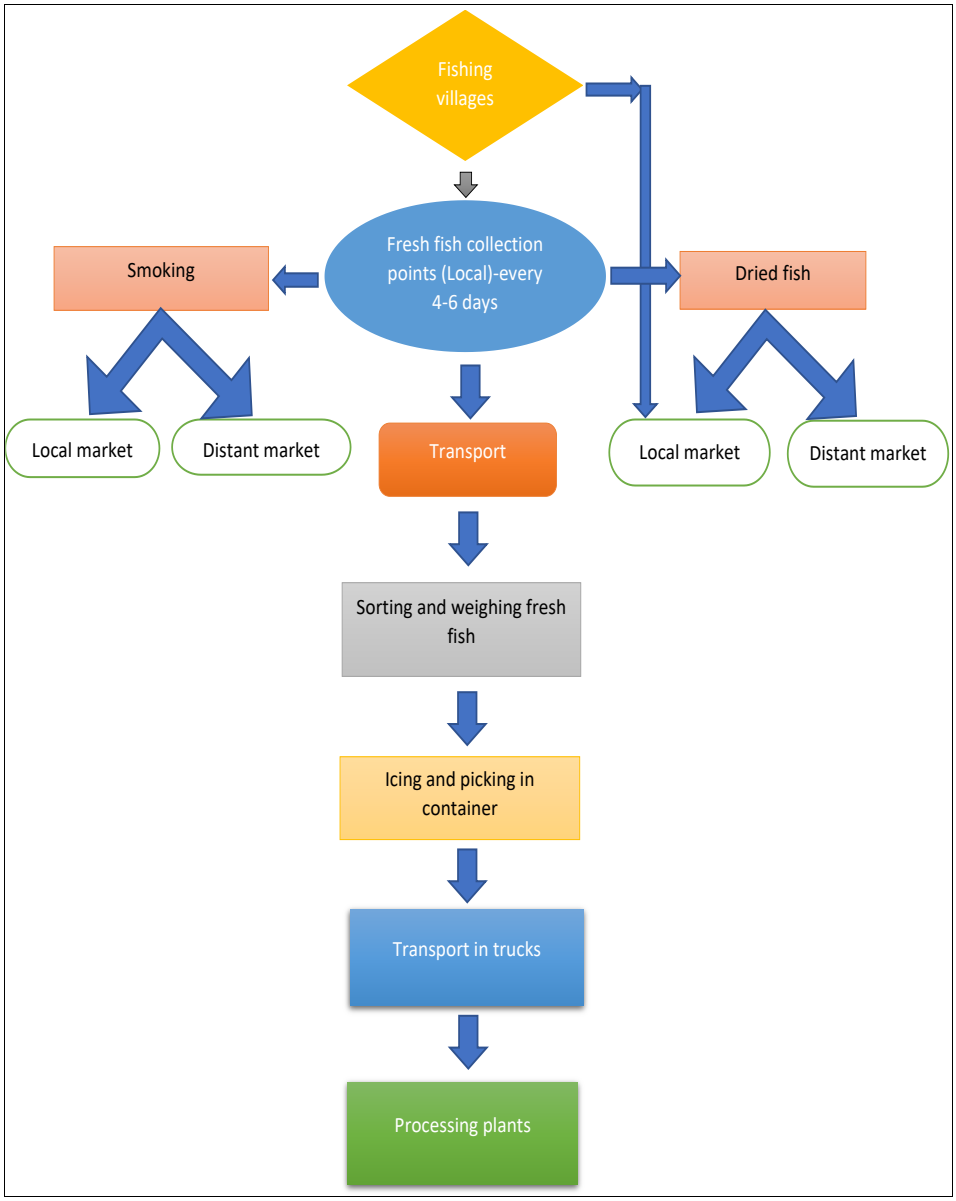
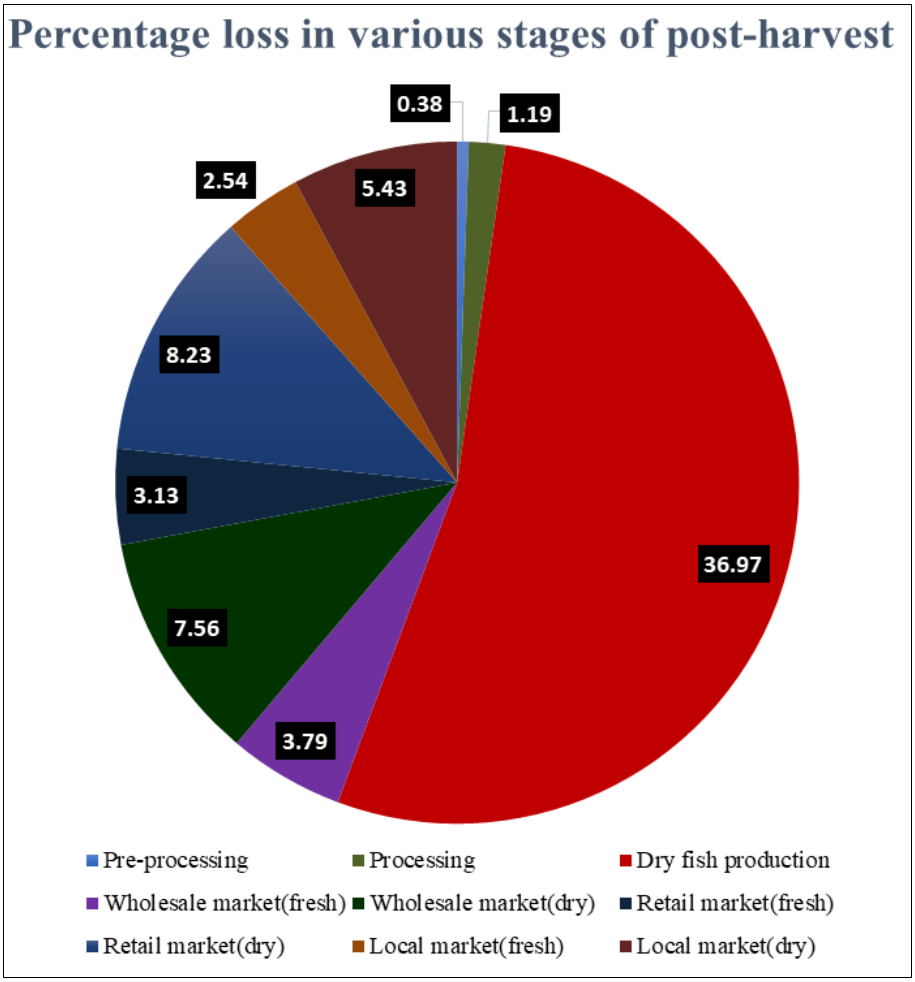


Fig 5: The flow chart displaying the activities in a fish landing point



Note: Walking around the fishing area of a particular location will help you to observe the fishery activities and the stakeholders involved in the same. A thermometer can be kept to record the temperature of the fresh fish in order to assess the effectiveness of any chilling method or temperature abuse. Weighing scales can be employed to measure traditional units of measurement and weights used. A camera will help us to record important observations in the field like activities and losses etc.

Fig 6: Percentage loss occur in various stages of post-harvest

Loss reduction interventions

The basic idea of the assessment of PHFL using the three-tier approach is to evaluate their significance and to devise methods to reduce the losses. There can be definitions that can refine the national policy dimensions, which can be formulated based on the significance of the circumstances. National policies can be reframed to avoid the loss, which in turn will ensure food security. It is important for policy makers to visualize how a projected intervention reduce the PHFL and supports the national level food security policy. Loss reduction interventions can take many forms. Some of them are promoting the live fish marketing, capacity building/skill development programmes in hygienic fish handling, sanitation, processing, marketing and business management. The nationwide programmes can also be organized to improve the access of fish sellers to markets and services, improved access to modern technology, credit, and better implementation of appropriate legislation and value addition schemes. The objectives of these interventions should be always specific, consistent and attainable. To be specific, it must clearly understand what is to be accomplished, and how it will be evaluated. To be consistent, an objective must be compatible with existing national/international policies in the fisheries sector. Some of the focused loss reduction objectives can be, 1) improving the quality of harvested fish by 50%, 2) value of the fish can be increased by 30-40%, 3) fish discards may be reduced by 60-80%, 4) value addition of low value fish catch by 40-50%, 5) development of five new products from the low value bycatch, 6) development of real-time market information system, 7) introduction of three new technologies in fish preservation for a specific geographical region, and 8) extending the opportunities for live-fish marketing by two times. The adoption of any such intervention will depend on issues, such as whether fishermen are aware of the intervention, the benefits, investment cost, workability and cultural acceptance.

Fig 7: PHFL reduction interventions

Conclusions

FAO estimates place the losses for fisheries sector highest among the agriculture and allied sectors. Globally, the demand for quality fish is growing rapidly day by day and real-time systems are required to reduce the PHFL. These interventions can create a big impact in 1) improving the quality and quantity of fish supply, 2) producer-consumer satisfaction and 3) overall development of the sector. To achieve this goal, there requires coordination and joint activities from all the stakeholders in the fisheries sector to improve the value, quality and the compatibility of the fish harvested. The implementation of resolutions to reduce PHFL requires substantial resources including trained personnel and novel technologies. International efforts must be pooled to research and extension activities specifically directed to PHFL.

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