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Original Article

Quantifying physical and market losses of hilsa fish (*Tenualosa ilisha*) value chain: a nationwide assessment of fishers and traders

Shamima Akter Toma[1] • Rupam Bhoutika[1] • Md. Mahfuzul Hasan[2] • Mohammad Ismail Hossain[1] • Md. Akhtaruzzaman Khan[3] • Md. Salauddin Palash[1]

[1] *Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh*
[2] *SMART Project, Palli Karma Sahayak Foundation (PKSF), Dhaka 1207, Bangladesh*
[3] *Department of Agricultural Finance and Banking, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh*

Correspondence
Md. Mahfuzul Hasan; SMART Project, Palli Karma Sahayak Foundation (PKSF), Dhaka 1207, Bangladesh
mahfuzul44998@bau.edu.bd

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Abstract
Post-harvest loss of fish remains a critical challenge affecting food security and economic sustainability in Bangladesh. This study assessed the magnitude and causes of post-harvest loss of hilsa fish across Bangladesh at both the fishers and traders' levels to estimate physical and market losses and identify the key factors contributing to these losses. A total of 4025 respondents, including 1312 fishers and 2713 traders, were surveyed using structured questionnaires. For data analysis, this research applied the questionnaire loss assessment method (QLAM) and descriptive techniques. Findings showed that the physical and market losses during the capture was 45.06 kg per metric ton (MT), consisting of 1.41 kg physical loss (quantity) and 43.65 kg market loss (economic loss due to reduced selling price). Notably, market loss was higher at the trader level compared with the fisher level. Among all traders' maximum market loss was found at Bepari level (12.58 kg MT^{-1}), following the retailer level (9.98 kg MT^{-1}) and minimum loss was found at aratder level (2.42 kg MT^{-1}). Quality deterioration and unfavorable market conditions, such as excess supply and reduced demand, were identified as the major contributors to losses. Physical loss mainly resulted from prolonged harvesting time, high temperature, and delayed marketing. The study concluded that post-harvest loss of hilsa was primarily driven by market-related factors rather than physical damage. Improving handling practices, strengthening cold storage facilities, and enhancing market management could reduce these losses and improve economic outcomes.

Keywords: fish value chain; hilsa fish; market loss; post-harvest loss; *Tenualosa ilisha*

1 | INTRODUCTION

Hilsa (*Tenualosa ilisha*) is the most popular and iconic fish in Bangladesh, contributing significantly to national fish production, employment generation, and economic return (DoF 2019). Hilsa has become the king of fish due to its incomparable taste, smell, and nutritious oil. The incomparable flavor of hilsa has been ascribed predominantly to the appearance of the indicative number of fatty acids (Nath and Banarjee 2012). Hilsa is locally called 'Illish' in Bangladesh and it has given the status of national fish of the country. In 2016, hilsa of Bangladesh had been recognized as a GI (Geographical Indication) prod-

uct. In south Asia, hilsa has traditionally been using to prepare various mouthwatering delicious items of food in different religious and cultural festivals (Ahsan *et al*. 2014). It has both economic importance and cultural value in south Asia (Mittu *et al*. 2026). During the celebration of 'Pohela Boishakh' (Bangla new year) in Bengali culture, 'Jamai Shashthi' in India and Nepal, and 'Puja" majority of the people want to have a taste of hilsa. Moreover, it is also an important source of protein. In the fiscal year 2023–24, annual hilsa production from inland and marine fisheries was 10.55% (0.529 million metric ton) to the country's total fish production (DoF 2024). Hilsa has been contributing more than 1% to the GDP in Bangladesh, and more than 2.0–2.5 million fishermen are dependent on hilsa fishing (Jahan *et al*. 2015; DoF 2020). The rivers of Bangladesh are the major source of hilsa production and the government have been trying to produce more hilsa by adopting various policy initiatives and implementing those policies effectively.

Fish output is decreasing as a result of changing climatic phenomena that have a substantial impact on aquatic ecosystems, such as global warming, ocean acidification, high water temperatures, inadequate precipitation, changes in monsoon patterns, and extreme occurrences (Hossain *et al*. 2025). The decline in food quality and quantity across the whole value chain, from harvest to consumption or final use, is referred to as post-harvest loss (PHL) (Hodges *et al*. 2011; Jha *et al*. 2015; Kimiywe 2015). In fisheries, PHL includes both qualitative and quantitative losses. Quantitative loss encompasses physical and market losses. Fish that is thrown away (accidentally, voluntarily, or as permitted) or consumed by insects, birds, or animals is considered physical loss. Fish are mostly physically lost as a result of improper handling and being discarded at sea because they are undersized or will not fetch a high price (Diei-Ouadi and Mgawe 2011; Olusegun and Matthew 2016). The most critical stage for the hilsa fish is its harvesting time.

On the other hand, market loss specifically refers to losses as a result of market dynamics like excess supply and decreased demand as well as quality degradation. However, the market loss categorized into two types such as quality loss and market force loss. Fish that has undergone changes (due to spoiling or physical damage) and is sold for less than if there had been no or minimal deterioration in quality is considered quality loss; any loss brought on by market trends, where fish operators are forced to sell at a price lower than their expectations at the time of production, is considered market forces loss (Akande and Diei-Ouadi 2010). Any point in the post-harvest chain can experience PHL (Baral and Hoffmann 2018).

Bangladesh is a Southeast Asian developing country and PHL is common in Southeast Asian developing nations- during handling and storage (6%), processing and packaging (9%), distribution (15%), and consumption (2%) (Gunasekera *et al*. 2017; Islam *et al*. 2025). Loss of revenue, quantity, quality, food security, nutritional value, and time are also linked to these losses. In addition to losses brought on by bug infestation, smoked or dried fish breaking, using fish as animal feed, cheap prices, and improper handling (Akande and Diei-Ouadi 2010). It has been estimated that, overall post-harvest physical loss of capture, culture and marine fisheries were 3.37 kg MT^{-1}, 0.99 kg MT^{-1} and 10.53 kg MT^{-1} and 56.33 kg MT^{-1} respectively (Prodhan *et al*. 2022).

Existing literature (e.g. Nowsad 2010; Nowsad *et al*. 2015; Gyan *et al*. 2020; Rashid and Sarkar 2020; Torell *et al*. 2020) pointed that, one of the causes of the significant economic gains lost across the value chain is losses from harvest to consumption. In the case of high-value inland capture fish species, PHL was higher for hilsa that causes highest total monetary loss around \$12.35 ton^{-1} (Prodhan *et al*. 2022). Securing post-harvest benefits through post-harvest loss control of hilsa will help to improve livelihood, food security and overall economic growth of Bangladesh. This may improve country's GDP but sufficient attention has not been given to PHL in policies (Tesfay and Teferi 2017; Ambler *et al*. 2018). Nonetheless, reducing PHL throughout the fisheries value chain has been found to be a policy tool that enhances the livelihoods of the value chain's participants and helps to improve employment, food security, and poverty (Odoli *et al*. 2019; Rashid and Sarkar 2020).

Physical and market losses in Bangladesh's fishing industry have been found and measured by a number of empirical researches. However, prior studies only show the total amount of losses in a certain species in a particular region. Thus, the present study was conducted to generate countrywide information on total post-harvest loss, physical loss, market loss of capture hilsa fish in Bangladesh. Yet the study is expected to elicit interesting information about the number of factors which are responsible for these physical and market losses of hilsa fish. Besides, such study can form a basis for future comprehensive and in-depth studies of physical and market losses analysis. The findings will be useful for value chain actors and provide guidance for policymakers. Thus, the objectives of this research are to identify and estimates post-harvest physical loss of hilsa fish, to ascertain post-harvest market loss of hilsa fish and to identify the causes that are responsible for physical and market losses of hilsa fish.

2 | METHODOLOGY

2.1 Study area and sampling design

Since the aim of the study was to generate countrywide information on the post-harvest loss and the factors affecting post-harvest loss of inland capture hilsa fish,

therefore; the study covered 173 upazila of 64 districts under eight divisions. The sub-districts were selected based on the sources of fish, environmental heterogeneity, geographical characteristics, Types of water bodies, water availability, etc. A total of 4025 samples were designated from the chosen areas, of which 1312 were hilsa fisher and 2713 were hilsa trader. The study covered 1463 markets throughout the country. The data was collected over an 18-month period in 2019 and 2020, and 12 enumerators were permanently involved in the data collection process during the project period. Random sampling technique was followed to select fisher, while traders (Local agent, Bepari, Paiker, Aratdar, Commission agent, Retailer) were selected through snowball sampling technique.

2.2 Data collection tool

The interview schedule focused on various value-adding stages of hilsa fish, including fishing, landing, processing, and selling, emphasizing causes of fish degradation. Respondents were asked about the quantity and grades of fish traded, and a distinct schedule was created for fishers and traders. Pre-testing ensured the questionnaire's appropriateness, subsequent adjustments improved data accuracy, and primary data was collected via structured interviews and all the descriptive analysis were conducted using Excel software.

2.3 Explanation of terms

To ensure clarity and consistency in interpreting the roles of different value chain actors and categories of losses, key terms used in this study are defined and summarized in Table 1.

2.4 Quantitative loss estimation models

The estimation of physical and market losses followed the questionnaire loss assessment method (QLAM) developed by the Food and Agriculture Organization (FAO) and the Natural Resources Institute (NRI), which has been widely applied for large-scale fisheries loss assessments (Diei-Ouadi and Mgawe 2011; Prodhan *et al*. 2022; Mandal *et al*. 2024). The method quantifies both physical and market losses using information collected directly from fishers and traders. Physical loss represents the actual quantity of fish discarded or rendered unusable, whereas market loss represents the economic loss resulting from quality deterioration and adverse market conditions such as excess supply or reduced demand. The equations used in this study are presented below, and all variables are explicitly defined to facilitate reproducibility.

2.4.1 Estimation of physical loss: The following equation was applied to estimate the physical loss:

$$Q_{pl} = Q_d / Q_t \times 1000$$

where, Q_{pl} = Quantity of physical loss (kg MT^{-1}); Q_d = Quantity of discarded fish (kg); Q_t = Quantity of total harvested fishes (kg).

The corresponding monetary value of physical loss was estimated as:

$$M_{pl} = Q_{pl} \times P_m$$

where, M_{pl}= Monetary value of physical loss (BDT MT^{-1}); and P_m= Market price of good quality hilsa fish (BDT kg^{-1}).

TABLE 1 Definition of value chain actors and loss categories.

Category	Definition
Fisher	A person engaged in capturing or harvesting fish from natural water bodies such as rivers or open waters for commercial purposes.
Faria / Local agent	An intermediary who facilitates transactions between fishers and buyers (e.g., paiker, bepari, commission agents, and retailers) and receives a commission for their services (especially in the local area).
Bepari	A wholesaler who purchases large quantities of fish and transports them across districts for resale.
Paiker	A local wholesaler who trades fish within a specific district or regional market.
Aratdar	A commission-based trader who provides auction facilities and may store fish temporarily before resale.
Commission agent	An intermediary who arranges fish sales through auctions and earns a commission (typically 2–6%) from sellers and sometimes buyers.
Retailer	A trader who sells fish directly to consumers in small quantities for final consumption.

2.4.2 Estimation of market loss: The monetary value of the market loss was measured based on the price loss due to the quality deterioration or market dynamics, which is expressed as:

$$L_i = P_m - P_s$$

where, L_i= Price loss per kilogram for quality grade i (BDT kg^{-1}) and P_s= Reduced selling price after deterioration (BDT kg^{-1}).

2.4.3 Estimation of quality loss: Hilsa fish were classified into three quality grades (Table 2), according to the reduction in market price. In this study, quality loss was categorized into three types and ordered as medium (Grade A), poor (Grade B), and poorest (Grade C) quality of fish based on the extent of the quality defects, which are often sold at a lower price than the market price.

The monetary loss for each quality grade was calculated as:

$$M_i = ((Q_i \times L_i) / Q_t) \times 1000$$

where, M_i= Monetary value loss for quality grade i (BDT); Q_i= Quantity of fish belonging to quality grade i (kg); PL= Price loss per kilogram (BDT kg^{-1})

The equivalent quantity loss on a market-price basis was estimated as:

$$QL_i = M_i / P_m$$

where, QL_i= Equivalent quantity loss due to price reduction (kg MT^{-1}); P_m = Market price of good-quality fish (BDT kg^{-1}). The same procedure was applied separately for Grade A, Grade B, and Grade C fish.

TABLE 2 Definition of loss categories.

Category	Definition
Grade A (medium quality)	Fish sold at a price ≤50% below the prevailing market price of fresh, good-quality Hilsa fish.
Grade B (poor quality)	Fish whose market price decreases by >50% compared to the price of good-quality fresh fish.
Grade C (poorest quality)	Fish that are no longer suitable for human consumption and are sold at minimal value for alternative uses.

2.4.4 Estimation of market-force loss: Similarly, the monetary value loss and the quantity loss arising from market-forces effects (such as excess supply or lower demand, as reported in Table 6) were estimated using the following equations:

$$M_e = ((Q_e \times L_e) / Q_t) \times 1000$$

where, M_e= Monetary value loss due to excess supply or lower demand (BDT); Q_e= Quantity of fish affected by excess supply or lower demand (kg).

$$QL_e = M_e / P_M$$

where, QL_e = Equivalent quantity loss due to price reduction (kg MT^{-1}) due to excess supply or lower demand.

The equations were applied separately to the excess-supply and lower-demand quantities to generate the two rows reported in Table 6.

To better understand and quantify the extent of post-harvest (PH) loss, respondents were asked to identify the causes of physical and market loss and estimate the quantity of loss. Then the factors were ranked according to attributable to each factor the severity loss by using descriptive analysis. Sources of capture may cause the variation in the factors influencing physical and market losses and its impacts on physical loss and market loss may be different, which could help generate specific information for policy insights. The physical and market loss specific to factors were measured based on information provided during the interview.

3 | RESULTS

3.1 Value chain mapping

3.1.1 Value chain mapping of hilsa (inland): Due to its flavor, palatability, and glossy appearance, inland or freshwater hilsa is becoming more and more popular both domestically and abroad. The top three value-adding channels out of all hilsa's available channels nationwide were depicted in Figure 1. Information on hilsa sales in Bangladesh was included in these three value chains. First, for BDT 553.04, 550, and 567.81 per kg, fishermen sold 58.75%, 15.75%, and 25.5% of their total catch to wholesalers (aratdar), wholesalers (bepari-1), and aratdar (commission agent).

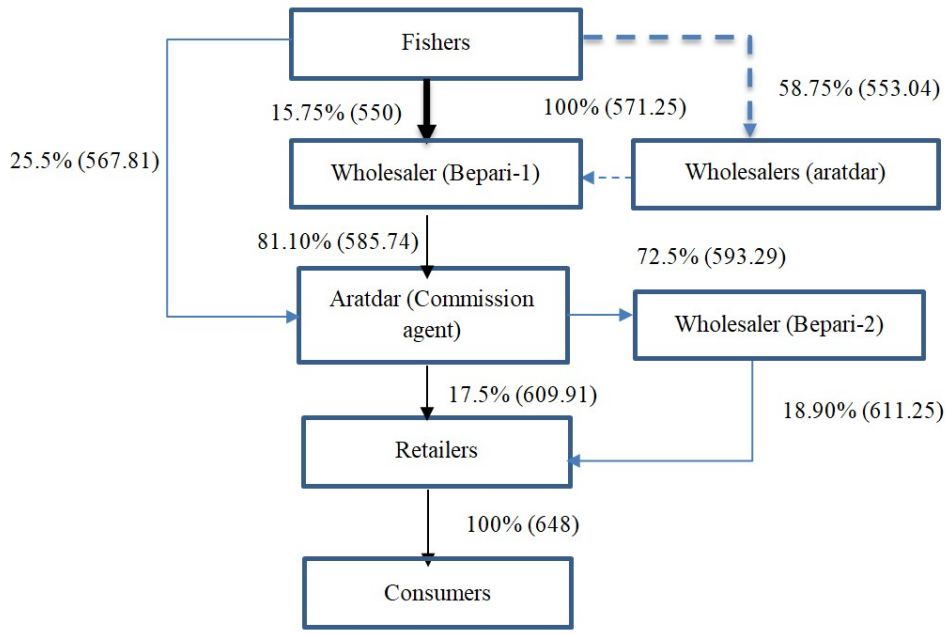


FIGURE 1 Value chain of hilsa (inland) in Bangladesh (the value in the parenthesis indicates the selling price (BDT kg^{-1}) of each market participant and percentage value indicates how much hilsa sold from one actor to another).

Fish from wholesalers (aratdar) were sold to wholesalers (bepari-1) for BDT 571.25 per kg. Bepari-1 then sold the fish to aratdar (commission agent) for BDT 585.74 per kg. Then, at BDT 593.29 per kg, aratdars (commission agents) sold 72.5% of the hilsa to wholesalers (bepari-2), who transported fish between districts. Retailers purchased the remaining fish for BDT 609.91 per kg. Hilsa was once more offered by wholesaler Bepari-2 to retailers at BDT 611.25 per kg. Lastly, shops sold hilsa to customers for BDT 648 per kg. It is important to note, nevertheless, that all graded fish, regardless of size, are included in this average price for hilsa fish. Therefore, the market price of larger-sized and medium-sized (graded) hilsa may differ from the average price.

3.1.2 Value chain mapping of marine hilsa: Marine hilsa is an essential source of revenue and cultural identity in southern Bangladesh. Figure 2 shows the major value chain mapping for marine hilsa. These canals are home to over 88% of Bangladesh's entire marine hilsa fish population. The main suppliers or producers in the hilsa value chain are fishermen. As soon as they dock, fishermen usually sell their catch to pre-arranged contracts with middlemen like aratdars. Fishermen sell the majority of their hilsa (88%) to aratdars at BDT 640 per kg, mostly to wholesalers, after harvest. Retailers (73%) receive the hilsa from wholesalers in various regions for BDT 658 per kg. Additionally, they sell 9% of their fish directly to customers for BDT 666 per kg. These are primarily spot buyers. Fishermen, however, sell 1% of the hilsa straight to freezing and salting processors for BDT 666 and 286 per kg, respectively.

Low-quality hilsa fish are sold to processors (salting) after being sorted out for a lower market price. Finally, about 9% of the hilsa moves from fishermen to suppliers or brokers at a rate of BDT 679 per kg, which eventually reaches exporters at a rate of BDT 706 per kg. The exporters often gather larger, high-quality hilsa fish that can be exported (at least 1 kg per fish). Fish were exchanged at a greater price because hilsa quality was maintained in accordance with customs regulations. The Department of Fisheries (DoF) Fish Quality Control (FQC) laboratory tests the fish's quality before to export, and it must meet the standards established by the regulatory agencies and quality control standards of the intended country.

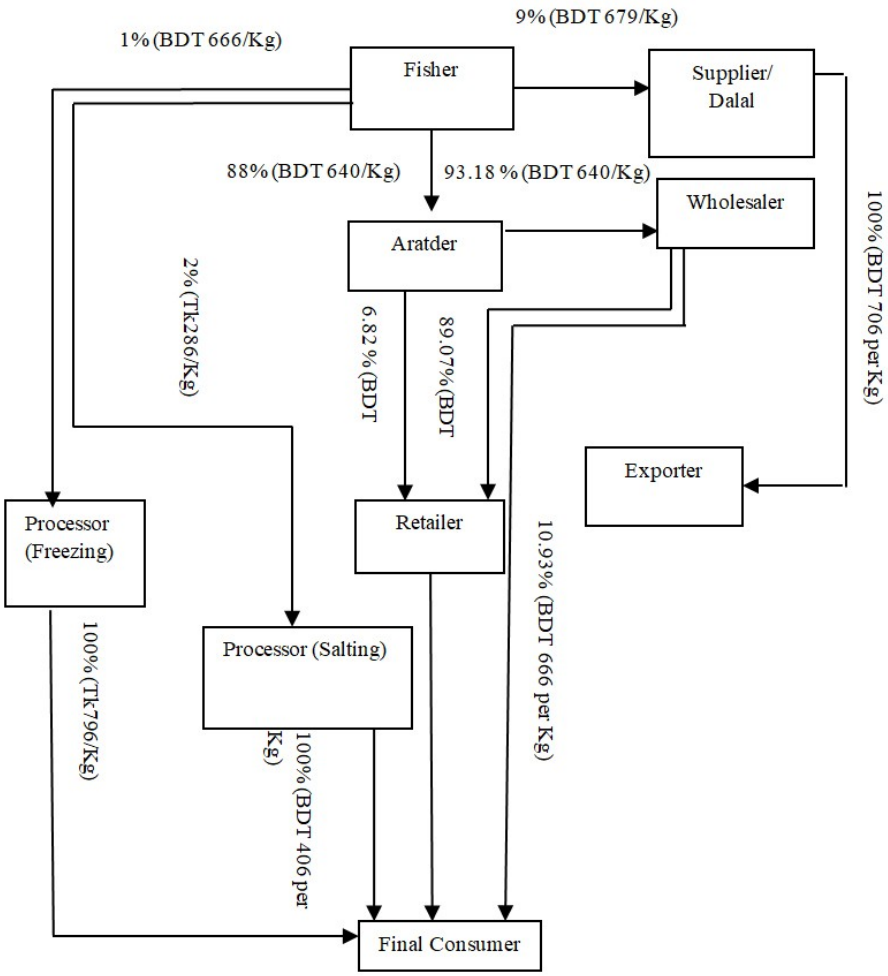


FIGURE 2 Marine hilsa value chain mapping (the value in the parenthesis indicates the selling price (BDT kg^{-1}) of each market participant and percentage value indicates how much hilsa sold from one actor to another).

3.2 Overall post-harvest loss of hilsa fish in Bangladesh

The overall post-harvest loss of hilsa fish in Bangladesh, considering both quantity and monetary value loss on market price, is highlighted in Table 3. In fisher side, the estimated overall physical and market losses was 10.47 kg MT^{-1}, and the total monetary loss estimated BDT 5602.31 per MT. On the other hand, overall physical and market losses for traders' level was 34.59 kg MT^{-1}. and the total monetary loss due to market price was estimated to be BDT 21485.71 per MT.

TABLE 3 Overall post-harvest loss (physical and market loss) of hilsa fish, compared between fisher and trader levels.

Physical and market losses types	Fishers		Traders	
	kg MT^{-1}	BDT MT^{-1}	kg MT^{-1}	BDT MT^{-1}
A. Physical loss	0.46	246.45	0.95	591.44
B. Market loss				
i) Quality loss				
Medium [a]	2.93	1,571.71	9.94	6,172.42
Poor [b]	1.39	743.45	7.67	4,765.83
Poorest [c]	0.07	35.53	0.04	21.95
ii) Market forces loss				
Excess supply	3.40	1,817.45	11.16	6,937.2
Lower demand	2.22	1,187.72	4.83	2,996.87
Total market loss (i+ii)	10.01	5,355.86	33.64	20,894.27
C. Total physical and market losses (A+B)	10.47	5,602.31	34.59	21,485.71

Note: a, b, c denotes the grade A, B, C quality fish respectively; BDT MT^{-1} = Bangladeshi Taka per metric ton. 1 USD = 124.54 BDT.

3.3 Magnitude of physical losses of hilsa fish

Fishermen suffered a total physical loss of 0.46 kg MT^{-1} and a monetary loss of BDT 246.45 per MT. The overall physical loss at the trader level was 0.95 kg MT^{-1} and monetary value loss was predicted to cost the economy BDT 591 per MT every year according to Table 4.

TABLE 4 Physical loss and monetary value loss of hilsa fish at fisher level.

Levels	Physical Loss, Q_{pl} (kg MT^{-1})	Monetary value of physical loss, M_{pl} (BDT MT^{-1})
Fisher	0.46	246.45
Trader	0.95	591.44

Note: Q_{pl} = Quantity of physical loss of hilsa fish, M_{pl} = Monetary value of physical loss. 1 USD = 124.54 BDT.

3.4 Magnitude of market losses of hilsa fish

3.4.1 Monetary value and equivalent quantity loss due to price reduction for quality at fisher level: In the analysis of monetary and quantity losses for hilsa fish at the fisher level (Table 5) elucidate, Grade A fish experienced a total quantity loss of 2.93 kg MT^{-1} with a monetary loss of BDT 1571.71 per MT. For Grade B fish, the total monetary loss was BDT 743.45 per MT and quantity loss was 1.39 kg MT^{-1}. Grade C fish showed minimal losses with BDT 35.53 per MT and 0.07 kg MT^{-1}.

3.4.2 Monetary value and equivalent quantity loss due to excess supply and lower demand at fisher level: Table 6 indicates a yearly excess supply of 114531 kg of hilsa fish, resulting in a monetary value loss of BDT 1817.45 per metric ton and a market price quantity loss of 3.40 kg per metric ton and total quantity loss of hilsa fish due to lower demand was 50324 kg $year^{-1}$, resulting in a monetary value loss of BDT 1187.72 per MT and a market price loss of approximately 2.22 kg MT^{-1} annually.

TABLE 5 Monetary value loss and equivalent quantity loss due to price reduction of selling grade A, B, c quality fish at fisher level.

Fish quality	Quantity (kg)	Monetary loss (BDT MT^{-1}), M_m	Quantity loss (kg MT^{-1}), Q_{Lm}
Grade A	87,378	1,571.75	2.93
Grade B	9,411	743.45	1.39
Grade C	344	35.53	0.07

Note: M_m = monetary value loss for selling A grade (medium quality) hilsa fish, Q_{Lm} = equivalent quantity loss due to price reduction for grade A quality hilsa fish. 1 USD = 124.54 BDT.

3.4.3 Monetary value and quantity loss due to selling Grade A, B, C quality at trader level: The financial value loss for different traders over the course of a year from the selling of Grade A hilsa fish divisions are shown in Table 7. With overall losses of BDT 1375.29 per MT, retailers suffer the most losses. Over the course of a year, the monetary value loss from selling Grade B hilsa fish among different sellers was also evaluated. At BDT 2399.50 per MT, the retailer suffers the most loss; the total financial losses for Grades A and B are BDT 6172.42

and 4765.83 per MT, respectively. Quality loss for grade A & B was 9.94 and 7.67 kg MT^{-1}. Grade C losses were observed only among commission agents and retailers. For commission agents, the monetary loss was BDT 16.48 per MT in Mymensingh and BDT 4.46 per MT in Dhaka, corresponding to equivalent quantity losses of 0.02654 and 0.00718 kg MT^{-1}, respectively. Retailers in Dhaka experienced a monetary loss of BDT 1.00 per MT, equivalent to 0.00163 kg MT^{-1}. No Grade C fish were reported for local agents, bepari, paiker, or aratdar.

3.4.4 Monetary value and quality loss for traders due to excess supply and lower demand

The monetary value loss due to excess supply and lower demand were BDT 6937.2 and 2996.87 per MT respectively (Table 8). Total equivalent quantity loss due to price reduction from excess supply and lower demand are 11.16 and 4.83 kg MT^{-1}.

TABLE 6 Monetary value loss and equivalent quantity loss due to excess supply and lower demand of hilsa fish at fisher level.

Reasons	Quantity (kg), Q_e	Monetary loss (BDT MT^{-1}), M_e	Equivalent quantity loss, Q_{le}
Excess supply	114,531	1,817.45	3.40
Lower demand	50,324	1,187.72	2.22

Note: Q_e = Quantity of hilsa fish affected by excess supply/lower demand (kg); M_e = monetary value loss due to excess supply/lower demand (BDT MT^{-1}); QL_e = equivalent quantity loss due to price reduction resulting from excess supply/lower demand (kg MT^{-1}). 1 USD = 124.54 BDT.

Table 7 Monetary value and quantity loss due to selling Grade A, B, C quality at trader level.

Actors	Monetary Loss (BDT MT^{-1})		Quality Loss (kg MT^{-1})	
	Grade A	Grade B	Grade A	Grade B
Local agent	545.45	397.93	0.878	0.6408
Bepari	1,727.09	1,035.84	2.781	1.6680
Paiker	1,278.12	273.95	2.058	0.4411
Aratder	546.85	570.74	0.881	0.9191
Commission agent	699.53	87.87	1.126	0.1415
Retailer	1,375.29	2,399.50	2.215	3.8639
Total	6,172.42	4,765.83	9.94	7.67

1 USD = 124.54 BDT.

TABLE 8 Monetary value and equivalent quantity loss for traders due to excess supply & lower demand of hilsa fish.

Actors	Excess supply		Lower demand	
	Monetary value loss (BDT MT^{-1})	Equivalent quantity loss on market price (kg MT^{-1})	Monetary value loss (BDT MT^{-1})	Equivalent quantity loss on market price (kg MT^{-1})
Local agent	219.63	0.35	383.23	0.62
Bepari	4,657.73	7.50	388.98	0.63
Paiker	627.83	1.01	568.66	0.92
Aratder	291.26	0.47	92.34	0.15
Commission agent	330.60	0.53	400.45	0.64
Retailer	810.15	1.30	1,163.21	1.87
Total	6,937.2	11.16	2,996.87	4.83

1 USD = 124.54 BDT.

3.5 Factors affecting post-harvest physical and market loss

3.5.1 Causes of post-harvest physical loss at farm level: To assess physical loss in the capture of hilsa fish, various causes and their impact were evaluated. The primary factor contributing to physical loss was identified as longer harvesting duration, accounting for 43% of the total loss. This was followed by delays in marketing and higher temperatures, both contributing 42% to the loss (Figure 3). Inappropriate harvesting methods resulted in an additional 6% loss. Other factors such as inadequate cold-storage facilities, insufficient quality ice, lack of insulated containers, and poor communication and transportation systems exacerbated the issue, corroborating findings from Adelaja *et al*. (2018), Gyan *et al*. (2020), and Torell *et al*. (2020).

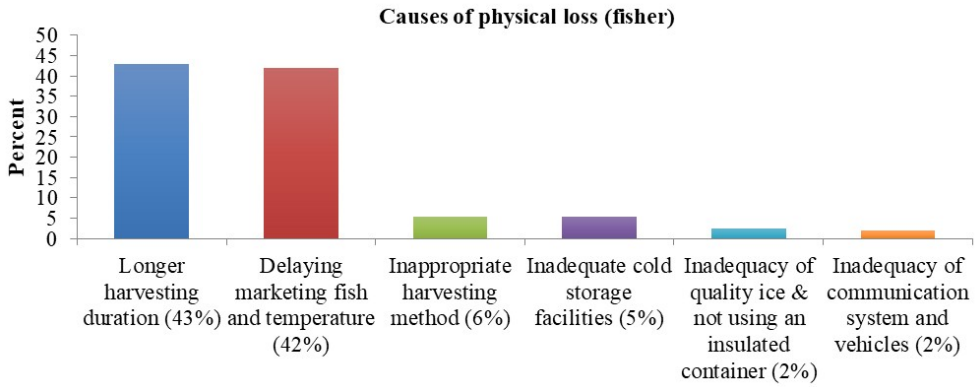


FIGURE 3 Major causes of physical post-harvest loss at the fisher level (percentages represent the proportion of the total reported physical loss attributed to each cause).

3.5.2 Causes of post-harvest market loss at fisher level

In hilsa fisheries, market loss results from multiple factors, with the study identifying 19 major causes shown in Table 9. Among the reported causes, excess supply accounted for the largest share of market loss (46.09%), followed by lower demand (19.93%). Delayed marketing and temperature issues contributed an additional 13.06% loss, while delays in sales resulted in 5.53% loss, with longer harvesting duration causing 3.11%. Insufficient ice and lack of insulated containers lead to a 2.23% quality loss during storage and transport. Other causes include insufficient market information (1.83%), inappropriate harvesting methods (1.82%), and inefficient transportation (1.69%). The study corroborates findings from previous research by Ahmed *et al*. (2008), Gyan *et al*. (2020) and Torell *et al*. (2020).

TABLE 9 Causes of post-harvest market loss at fisher level.

Problem faced by fishers	Quantity loss (%)
Excess supply	46.09
Lower demand	19.93
Postponing the sale of fish and temperature	13.06
Sale delay	5.53
Longer harvesting duration	3.11
Inadequacy of quality ice & not using an insulated container	2.32
Insufficient market information	1.83
Inappropriate harvesting method	1.82
Inefficient transportation	1.69
Inadequacy of storing equipment	1.67
Inadequate open-hand fish processing system	1.18
Long-term auction in a sunny location	0.58
Supply at wrong time	0.48
restrictions on consumers' purchasing power	0.27
Tradesmen's deliberate delay in buying fish	0.19
Contamination and poisoning	0.09
Inadequate system for loading and offloading	0.07
Unhygienic environment	0.06
Rodents by animals & insects	0.04
Total	100.00

3.5.3 Causes of post-harvest physical loss at traders' level:

The physical loss of hilsa fish at the traders' level was notable, attributed mainly to inadequate insulated containers, high temperatures, and insufficient cold storage (Figure 4). One-third of the loss was due to the non-use of insulation and ice, with traders requiring large amounts of ice for storage and transportation. High temperatures contribute 24.44% to the loss, while deficient cold storage accounts for 7.35%, and transportation issues lead to 18.62% of the total physical loss. Additional factors include communication system inadequacies (9.41%) and insufficient storage equipment (3.56%).

3.5.4 Causes of post-harvest market loss at traders' level:

The data illustrates that approximately 43.12% of market loss at the trader level was attributed to an excess supply of hilsa fish, the leading cause. Other factors based on respondents' observation included lower demand (18.86%), delay in sale (13.87%), fish damage during transportation (4.55%), and quality loss due to high temperature (3.71%). Additional causes such as delivery delays (1.81%), incorrect market timing (1.58%), and various post-harvest issues like insufficient storage, inadequate ice usage, and environmental factors also contribute to these losses (Figure 5).

4 | DISCUSSION

The findings demonstrate that physical and market losses in the hilsa value chain is driven predominantly by market-related losses rather than physical wastage. Market-related losses were substantially greater than physical losses, indicating that value erosion in the hilsa value chain was driven by both quality-related price reductions and unfavorable market conditions, rather than physical wastage alone. This distinction highlights the importance of considering both physical and market-related losses when assessing the economic consequences of post-harvest problems. The findings therefore suggest that maintaining fish quality and market value throughout the value chain is as important as reducing physical damage.

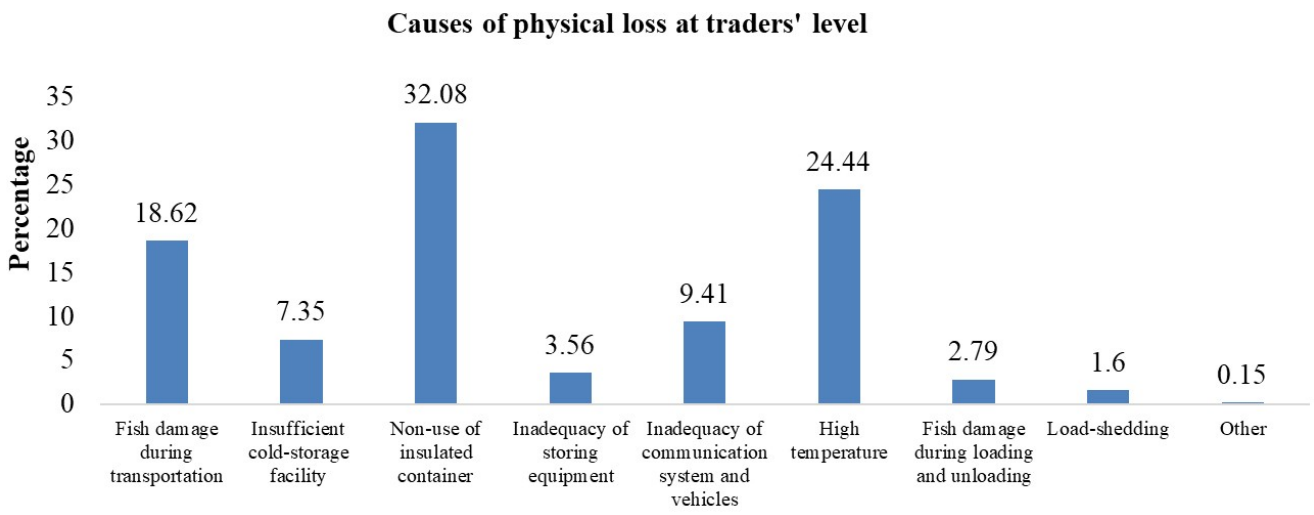


FIGURE 4 Major causes of physical post-harvest loss at the trader's level. Percentages represent the proportion of the total reported physical loss attributed to each cause.

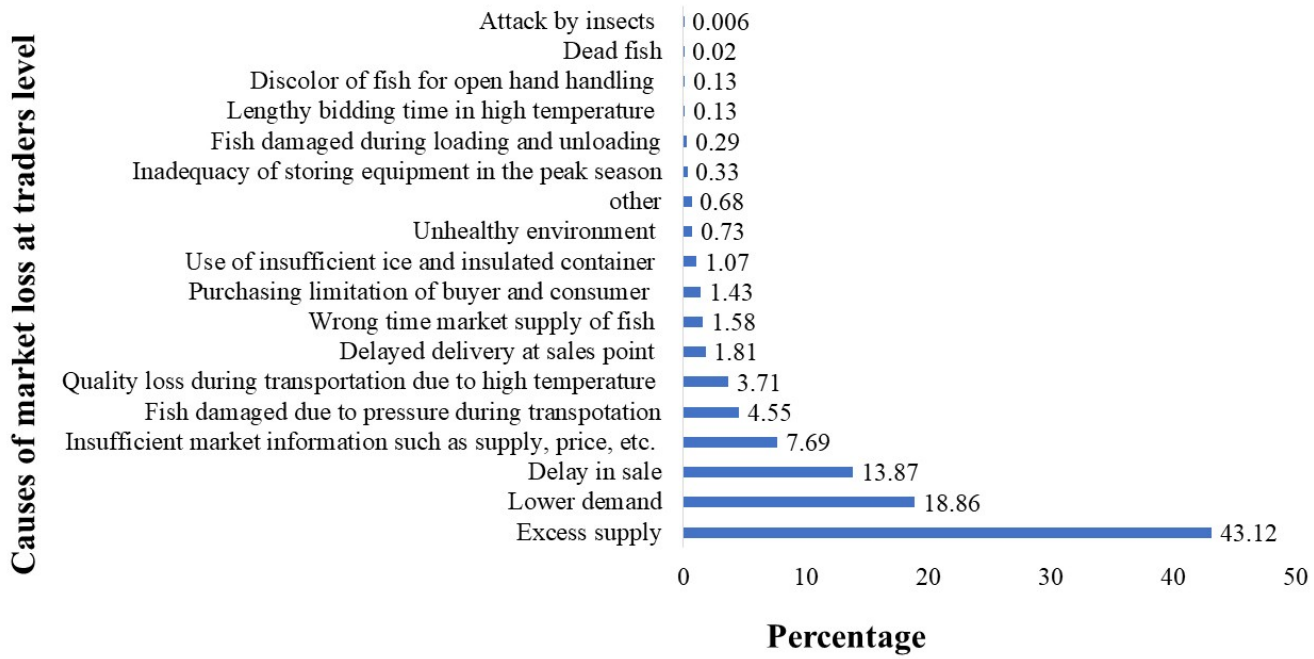


FIGURE 5 Major causes of market post-harvest loss in the hilsa value chain in the trader's level. Percentages represent the proportion of the total reported market loss attributed to each cause.

Losses were consistently higher at the trader level than at the fisher level. This pattern can be explained by the cumulative effects of longer marketing and transportation processes, repeated handling, inadequate storage, and exposure to unfavourable conditions as fish move through multiple intermediaries. After landing, hilsa may pass through several traders before reaching consumers, increasing its exposure to handling and environmental conditions. Inadequate icing, unsuitable containers, insufficient cold-storage facilities, prolonged exposure to high temperatures, and damage during loading and unloading can progressively reduce fish quality. Similar constraints have been reported in Bangladesh, where inadequate icing, inappropriate transportation and storage facilities, and poor handling practices contributed to deterioration of fish quality along the distribution chain (Hossain *et al*. 2012). Thus, the higher trader-level loss observed in this study appears to reflect structural constraints associated

with the movement and handling of a highly perishable product rather than a single point of inefficiency.

The causes of physical loss identified in the study further support the importance of post-harvest handling. At the fisher level, longer harvesting duration and the combined effect of delayed marketing and high temperature were the major reported contributors to physical loss, while at the trader level, non-use of insulated containers, transportation damage, high temperature, and inadequate cold-storage facilities were prominent. These factors are interconnected, as inadequate cooling and prolonged exposure to high temperatures can contribute to quality deterioration, while delays in transportation and marketing increase the time available for quality degradation. The findings are broadly consistent with previous research showing that poor handling and inadequate post-harvest facilities are important sources of fish losses in small-scale fisheries (Akande and Diei-Ouadi 2010; Gyan *et al.* 2020; Torell *et al*. 2020). This indicates that improvements in cold-chain management and handling practices could reduce both physical losses and the subsequent reduction in market value.

An important finding of this study is the dominant contribution of excess supply to market loss, particularly at both fisher and trader levels. During periods of abundant landings, limited storage capacity may constrain the ability of value-chain actors to delay sales, even when market prices are unfavorable. Because hilsa is highly perishable, fishers and traders have limited flexibility to postpone sales until market conditions improve. Consequently, excess supply may place downward pressure on selling prices, contributing to market-force losses. This suggests that market loss is influenced not only by lower demand but also by the ability of value-chain actors to manage periods of excess supply.

The findings have several practical implications. Interventions should not focus exclusively on fishers because a substantial proportion of losses occur during trading, transportation, storage, and marketing. Improving the availability of quality ice, promoting appropriate insulated containers, strengthening cold-storage facilities, and improving transportation and handling practices could help maintain fish quality after landing. At the same time, better market coordination and storage capacity could allow fishers and traders to manage periods of excess supply more effectively. Access to finance and training may also help value-chain actors adopt improved post-harvest technologies and handling practices. Overall, reducing physical and market losses in the hilsa sector requires an integrated approach combining improved physical infrastructure, cold-chain management, handling practices, and market management. Such interventions could reduce economic losses, improve returns to fishers and traders, and enhance the overall efficiency and sustainability of Bangladesh’s hilsa value chain.

5 | LIMITATION AND FUTURE RESEARCH

This study has been conducted to bring some new information and dimensions that might be helpful to increase the level of understanding on post-harvest loss of hilsa fish. But it is not free from limitation. This study included only capture hilsa fish of Bangladesh but marine hilsa fish also need further deep investigation. In addition, the estimates of post-harvest losses were derived from respondents' survey responses and therefore may be subject to recall bias and respondent subjectivity. Participants may not have remembered losses precisely, and some estimates may reflect personal judgment rather than direct measurements. To reveal the post-harvest loss and its’ causes within a fund and the time boundary might not allow us a deep investigation into this regard. With all these limitations, this study able to add some useful and practical information to our existing knowledge. Future studies should incorporate longitudinal data collected under normal market conditions and apply analytical approaches that allow comparison across regions and value chain actors.

6 | CONCLUSIONS

The study computed physical and market losses and identified their causes based on survey data. The market loss was found to be greater than the physical loss after the hilsa fish's physical and market losses were estimated. Among the factors reported by respondents, excess supply accounted for the largest share of market loss at both fisher and trader levels. Additionally, excessive temperatures and delayed sales were also linked to both physical and market losses. Furthermore, Bangladesh's hilsa fish market and physical losses were caused by the lack of processing and storage input resources like ice. Enhancing the ability of the hilsa fish value actors can be aided by the government and associated fisheries organizations. Chain since the majority of participants was impoverished and lack advanced expertise in fish handling, processing, and harvesting. For example, improved post-harvest technology was essential for maintaining fish and fishery product quality, food safety, and lowering physical and market losses, and access to financing was a critical need throughout the entire fisheries value chain. For producers to effectively arrange, handle, sell, and store fish and fish products as well as to meet food safety and quality regulations, well-constructed and maintained infrastructure—such as landing sites and market facilities was essential. In order to promote more active stakeholder participation and collaboration, there may also be provisions for the exchange of knowledge, skills, and resources that support physical and market losses reduction strategies. Future legislation that supports physical and market losses reduction initiatives should address these issues to manage Bangladesh's hilsa fisheries more actively, successfully,

and efficiently.

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ETHICAL APPROVAL
Ethics ensures that we conduct our research work with due respect for ethical considerations. All participants were informed of the purpose, procedures, and benefits of the research before they participated in the study. We further assured them that only the research team would have access to the data and any stored data through electronic means would be protected with appropriate security measures. They were permitted to ask questions and provide voluntary informed consent verbally to participate in this study. Respondents had a right to withdraw from the interview at any point in time of the conversation. This is to declare that; this is an original research endeavours and not submitted or published in any form anywhere.

CONFLICT OF INTEREST
The authors declare no competing interests.

AUTHORS' CONTRIBUTION
Shamima Akter Toma and Rupam Bhoutika: Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft preparation; Md. Mahfuzul Hasan: Visualization, Writing – review & editing; Mohammad Ismail Hossain, Md. Akhtaruzzaman Khan and Md. Salauddin Palash: Supervision, Validation, Writing – review & editing.

AI-USE STATEMENT
During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist with language editing, grammar, readability, and overall clarity. The authors reviewed and edited the resulting text and take responsibility for the accuracy, integrity, and final content of the manuscript.

DATA AVAILABILITY STATEMENT
All raw data can be accessed from the corresponding author on reasonable request.

REFERENCES
Adelaja OA, Kamaruddin RB, Chiat LW (2018) Assessment of post-harvest fish losses croaker *Pseudotolithus elongatus*, (Bowdich, 1825), catfish *Arius heudeloti*, (Valenciennes, 1840) and shrimp *Nematopalaemon hastatus* (Aurivillius, 1898) in Ondo State, Nigeria. Aquaculture and Fisheries 3(5): 209–216.

Ahmed MS, Sharif ASM, Latifa GA (2008) Age, growth, and mortality of hilsa shad, *Tenualosa ilisha* in the River Meghna, Bangladesh. Asian Journal of Biological Sciences 1(2): 69–76.

Ahsan D, Naser N, Bhoumik U, Hazra S, Bhattacharya SB (2014) Migration, spawning patterns, and conservation of hilsa shad (*Tenualosa ilisha*) in Bangladesh and India. Academic Foundation, New Delhi.

Akande G, Diei-Ouadi Y (2010) Post-harvest losses in small-scale fisheries: case studies in five sub-Saharan African countries. FAO Fisheries and Aquaculture Technical Paper 550. Food and Agriculture Organization of the United Nations, Rome, Italy. 72 pp.

Ambler K, de Brauw A, Godlonton S (2018) Measuring postharvest losses at the farm level in Malawi. Australian Journal of Agricultural and Resource Economics 62(1): 139–160.

Baral S, Hoffmann V (2018) Tackling post-harvest loss in Ghana: cost-effectiveness of technologies. International Food Policy Research Institute (IFPRI). Washington, DC.

Diei-Ouadi Y, Mgawe YI (2011) Post-harvest fish loss assessment in small-scale fisheries: a guide for the extension officer. FAO Fisheries and Aquaculture Technical Paper, 559I. Food and Agriculture Organization of the United Nations, Rome, Italy. 93 pp.

DoF (2019) National fish week 2019 compendium. Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh. 160 pp. (in Bangla).

DoF (2020) Yearbook of fisheries statistics of Bangladesh 2019–2020. Fisheries Resources Survey System (FRSS), Department of Fisheries. Bangladesh.

DoF (2024) Yearbook of fisheries statistics of Bangladesh, 2023–24. Fisheries Resources Survey System (FRSS), Department of Fisheries; Ministry of Fisheries and Livestock, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh 41: 140.

Gunasekera D, Parsons H, Smith M (2017) Post-harvest loss reduction in Asia-Pacific developing economies. Journal of Agribusiness in Developing and Emerging Economies 7(3): 303–317.

Gyan WR, Alhassan EH, Asase A, Akongyuure DN, Qi-Hui Y (2020) Assessment of postharvest fish losses: the case study of Albert Bosomtwi-Sam fishing harbour, Western Region, Ghana. Marine Policy 120: 104120.

Hodges RJ, Buzby JC, Bennett B (2011) Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. The Journal of Agricultural Science 149(S1): 37–45.

Hossain MM, Hassan MN, Lithi UJ, Nowsad AAKM (2012) Quality deterioration of wet fish caught in Mymensingh farm in different steps of distribution

channel towards Dhaka. Journal of the Bangladesh Agricultural University 10(2): 331–338.

Hossain MS, Zaman B, Khan MA, Shihab MYK, Nielsen R (2025) Impact of climate change and adaptation strategy in aquaculture: a systematic review. Aquaculture International 33(5): 330.

Islam MK, Majumdar BC, Khan M, Khan S, Abu M, … Rasul MG (2025) A review on olive and clove: promising natural additives for seafood preservation. Food and Humanity 4(1): 100539.

Jahan I, Ahsan D, Farque MH (2017) Fishers' local knowledge on impact of climate change and anthropogenic interferences on hilsa fishery in South Asia: evidence from Bangladesh. Environment, Development and Sustainability 19(2): 461–478.

Jha SN, Vishwakarma RK, Ahmad T, Rai A, Dixit AK (2015) Report on assessment of quantitative harvest and post-harvest losses of major crops and commodities in India. ICAR-All India Coordinated Research Project on Post-Harvest Technology, ICAR-CIPHET, P.O.-PAU, Ludhiana-141004.

Kimiywe J (2015) Food and nutrition security: challenges of post-harvest handling in Kenya. Proceedings of the Nutrition Society 74(4): 487–495.

Mandal AK, Rashid MMO, Sarkar MSK, Badiuzzaman, Rahaman MT (2024) Post-harvest losses in marine fisheries of Bangladesh. Heliyon 10(15): e35531.

Mittu B, Heena, Sharma R, Kaur S, Singh M, Dhanjal NIK (2026) *Typhonium* spp. In: Underutilized tuber crops of the Himalayan region (pp. 573–591). Academic Press.

Nath AK, Banerjee B (2012) Comparative evaluation of body composition of hilsa, *Tenualosa ilisha* (Hamilton, 1822) in different size groups with special reference to fatty acids, in Hoogly estuarine system, West Bengal, India. Indian Journal of Fisheries 59(2): 141–146.

Nowsad AA, Hossain MM, Hassan NM, Sayem SM, Polanco JF (2015) Assessment of post-harvest loss of wet fish: a novel approach based on sensory indicator assessment. SAARC Journal of Agriculture 13(1): 75–89.

Nowsad AKMA (2010) Post-harvest loss reduction in fisheries in Bangladesh: a way forward to food security. Final report PR 5(8): 171.

Odoli CO, Owiti H, Kobingi N, Obiero M, Ogari Z, ... Aura CM (2019) Post-harvest interventions in small-scale fisheries: a boon or bane to food and nutritional security in Kenya? Food Security 11(4): 855–868.

Olusegun OJ, Mathew OS (2016) Assessment of fish post-harvest losses in Tagwai Lake, Niger State, Nigeria. International Journal of Innovative Research and Development 5(4): 44–52.

Prodhan MMH, Khan MA, Palash MS, Rahman MT (2022) Nature, extent, and causes of post-harvest losses at fisher and farmer level: an in-depth study. Aquaculture 550(1): 737856.

Rashid MMO, Sarkar MSK (2020) Post-harvest losses of culture, capture, and marine fisheries of Bangladesh. International Journal of Business and Economy 2(2): 9–18.

Tesfay S, Teferi M (2017) Assessment of fish post-harvest losses in Tekeze dam and Lake Hashenge fishery associations: northern Ethiopia. Agriculture and Food Security 6(1): 4.

Torell EC, Jamu DM, Kanyerere GZ, Chiwaula L, Nagoli J, ... Freeman P (2020) Assessing the economic impacts of post-harvest fisheries losses in Malawi. World Development Perspectives 19: 100224.

R Bhoutika http://orcid.org/0009-0008-4826-7544
MM Hasan http://orcid.org/0009-0001-0193-8549
MI Hossain http://orcid.org/0000-0002-3213-2337
MA Khan http://orcid.org/0000-0002-2968-0375
MS Palash http://orcid.org/0000-0002-7558-7948