

VOL.66 NO.02 JULY-DECEMBER 2024 • PRINT ISSN 0025-3146 • ONLINE ISSN 2321-7898

# JMBAI

**JOURNAL OF THE MARINE  
BIOLOGICAL ASSOCIATION OF INDIA**



**MBAI**  
Marine Biological Association of India





# Did COVID-19 impact the livelihoods of marine fishers? Evidence from Bhaucha Dhakka fish market (New Ferry Wharf), Mumbai

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Received: 17 Jul 2023    Revised: 04 Jul 2024  
Accepted: 23 Aug 2024    Published: 25 Nov 2024

Original Article

## Abstract

The fishing sector in India employs more than 28 million people and contributes 1.1% of the country's GDP while producing 8.92% of the world's fish (2022-2023). COVID-19-induced lockdown and restrictions deeply affected and changed the supply-demand dynamics in the global marine fishing sector, which is crucially dependent on fish markets. This study focuses on the Bhaucha Dhakka (BD) fish market in Mumbai, one of the largest fish landing centres, where 1125 trawlers landed 67,927 tonnes of fish in 2018. The BD fish market infrastructure quality was assessed using the Food and Agriculture Organization's Fish Market Infrastructure Quality Index, which was found to be only 28% which categorises the market as *poor*. Specifically, the hygiene and cleaning aspects in BD need drastic improvement, which is classified as *very poor* (18%). Based on field observations and key informant interviews, five distinct marketing channels were identified in the market. The price spreads for popular fish species such as anchovies, seer fish, pomfret, Bombay duck, and shrimps, ranged from 16% to 50%, indicating *moderate to poor* marketing efficiency. The COVID-19-related restrictions, which interrupted the supply chain and widened price spreads, resulted in a significant decline of 31% (INR 15,289/USD~181) in the net monthly income of fishers. The lessons learned during and after the pandemic with reference to domestic and export fish markets need to be synthesised to draw insights for transforming the value chain in the fisheries sector. Modernising the markets with better infrastructure and support services under one roof is required to improve the structure, conduct, and performance.

**Keywords:** Bhaucha Dhakka fish market, COVID-19, fishers livelihoods, price spread, lockdown, impact

## Introduction

India is the world's second-largest producer of fish, contributing 8.12% of global production, 1.1% of the country's Gross Value Added (GVA), and more than 6.72% of the agricultural GVA (2022-2023). Furthermore, it plays a crucial role in sustaining the livelihoods of over 28 million people in India, particularly the marginal communities (Department of fisheries, 2023). During 2022-2023, India exported fish and fish products worth Rs. 63,969 crores (MPEDA, 2023), while fish consumption accounted for 20% of the total animal protein consumption for 3.2 billion people around the world (FAO, 2022).

The COVID-19 pandemic had devastating consequences for human health and socio-economic life. The pandemic is considered a rare global socioeconomic tremor that has disproportionately affected the informal sectors, including fisheries, leading to the drastic reduction in the income of fishers' and consumers' seafood consumption thereby impacting food security (Corlett *et al.*, 2020; Meharoof *et al.*, 2020; Mukherjee *et al.*, 2020; NOAA, 2020; White *et al.*, 2020; Love *et al.*, 2021). Owing to COVID-19 lockdown restrictions, fishing activity was badly hampered from March 2020 to April 2021. Further after the pandemic-related lockdowns and restrictions, in countries like India, fishing was affected due to the fishing ban during April-July (Deo, 2020; Korten, 2020; Avatar *et al.*, 2021). Even in small-scale fisheries, social distancing measures had prevented many fishers from fishing due to factors such as vessel size, marketing in congested local market areas, port closures, loss of access to cold storage, and the cancellation of shipping and air freight services (Bennett *et al.*, 2020; Orłowski, 2020). Due to the

outbreak of the pandemic, the number of active fishers and traders dropped significantly by more than 90%, while the average weight of catch per fishing trip increased across the board. Despite the fact that the average price per kilogram of fish was reduced by 20-70% as a result of the pandemic, fishermen who were able to continue fishing had larger average catches, so the daily catch value remained constant (Ocampo, 2020; FAO, 2020). But, this may not be universal and in a number of cases, there is no evidence to suggest that consumers benefitted from such price reductions. Most price reductions are facilitated by intermediaries (wholesalers, and transporters). High-value fisheries that enter export supply chains were hit harder than lower-value species that are regularly supplied to domestic markets (Campbell *et al.*, 2021). As local markets were oversupplied and export markets were closed, fish landed at large ports were kept idle in cold storage (George *et al.*, 2020; Mubarok and Ambari, 2020; Senten *et al.*, 2020). Due to decreased demand and price, capture fishery production has been temporarily halted or severely reduced, which may have a positive impact on wild fish stocks in the near future, providing some relief to marine ecosystems and possibly assisting small-scale fisheries in the long run (Knight *et al.*, 2020). While there are some positive aspects to this situation, such as food sharing and reduced fishing pressure, the negative repercussions seem to have outweighed the positive ones (Freduah *et al.*, 2017; Minahal *et al.*, 2020).

The COVID-19 pandemic had put everyone at risk of infection and transmission, including fishing communities and ports. Fishing communities have become “hotspots” for rapid infection due to the migratory lifestyle of fishers and the frequent influx of visitors. As a result, the employees working in the fisheries sector at these “hotspots” have been caught in a vicious cycle of starvation, unemployment, and debt, as highlighted by studies conducted by Sekhar *et al.* (2020) and Mandal *et al.* (2021). Given these circumstances, it becomes crucial to

examine the condition of fish markets and the livelihoods of fishers during the COVID-19 pandemic. Thus, understanding the structure, conduct, and performance of fish markets during COVID-19 is essential as it directly impacts the livelihoods of fishers and their families. Therefore, this study investigated the impact of COVID-19 and related restrictions on the Bhaucha Dhakka fish market and the fishers in the urban megalopolis of Mumbai. The market study has helped gain insights into the overall functioning of the market during the pandemic and the challenges faced by fishers.

## Material and methods

### Study area

The study was conducted at the Bhaucha Dhakka landing centre and fish market, which is situated on the Dockyard Road (Mazagaon) coastline in Mumbai, Maharashtra (Fig. 1). It is one of the largest fish landing centres, where 1,125 trawlers landed 67,927 tonnes of fish during 2018. Due to the prevailing pandemic, the study necessitated the adoption of an exploratory study design to conduct a rapid appraisal of the impact of COVID-19 on fishers. Primary data was collected through field visits, observation, and personal interviews with 10 key informants - trawl fishers who were available on the days of the visit and were willing to interact - at the Bhaucha Dhakka landing center and fish market during March-April, 2021. Primary data was also collected from wholesalers, retailers, purchase agents from the processing industry, retail consumers, and port trust staff through interviews. The information thus collected was cross-checked and triangulated with experts from ICAR-CMFRI (Central Marine Fisheries Research Institute, Mumbai), ICAR-CIFT (Central Institute of Fisheries Technology, Mumbai), ICAR-CIFE (Central Institute of Fisheries Education), MPEDA (Marine Products Export Development Authority), and DoF, Maharashtra through personal discussion and telephonic



Fig 1. Location of Bhaucha Dhakka Fish Landing Centre



Fig. 2. FMIQI scores

interviews. Secondary data on fish landings at Bhaucha Dhaka (1998-2018) were obtained from the Maharashtra State Department of Fisheries to understand the landing pattern and trend.

The standards and infrastructure in the fish markets were assessed using the FAO Fish Market Checklist framework. The framework consists of four dimensions namely reception/landing area quality, design of premises, hygiene and cleaning, and product quality, and each of these dimensions in turn contains several indicators (Fig. 2), the responses for which were obtained on a 5-point scale. Based on the indicator-wise and dimension-wise scores obtained, a composite measure of the Fish Market Infrastructure Quality Index (FMIQI) was obtained. Following the FMIQI score, the market was classified using the following typology: *very poor* (0 to 19), *poor* (20 to 39), *fair* (40 to 59), *good* (60 to 79), and *very good* (80 to 100) (Çakli *et al.*, 2013; Bunkar *et al.*, 2023).

This study focused on the market structure, market conduct, and market performance of the Bhaucha Dhakka fish market. Market structure refers to the characteristics of the market that shape the economic environment in which firms operate (Thomas and Maurice, 2011; Nzima *et al.*, 2014; Mebrate and Worku, 2019). The key characteristics include the presence of active buyers and sellers, degree of product differentiation, information about product price and quality, and entry-exit conditions (Hirschey and Pappas, 1996). Market conduct, on the other hand, examines the behaviour patterns and adaptations of actors within the market (Bain, 1968). It focuses on how actors respond to market dynamics and adjust their strategies. Market performance refers to the impact of market structure and conduct on various variables, such as pricing, costs, and production volume (Bressler and King, 1970). It assesses the outcomes achieved as a result of the strategic adjustments made by buyers and sellers in the market (Giroh *et al.*, 2010). This market structure-conduct-performance framework enabled us to gain insights through a rapid short-term study.

### History of Bhaucha Dhakka

Bhaucha Dhakka fish market, also known as New Ferry Wharf (NFW), is located on the southeastern seafront of the coastal city of Mumbai. The city, then known as Bombay, did not have a proper pier or wharf until 1835 when the colonial administration began leasing out land along the

waterfront to private individuals for the construction of wet docks and basins to promote trade and passenger transport. In 1841, a local inhabitant Laksman Hari Chandarjee Ajinkya, affectionately called 'Bhau', meaning 'big brother' in Marathi, built Bombay's first wet dock for the convenience of passengers and incoming ships to load, embark, and berth (Velkar, 2017). Even today, people are ferried to the villages across the Bay from the Bhau-Cha-Dhakka passenger terminal. Over the decades, Bhaucha Dhakka has become one of the three largest fish landing centres in the Greater Mumbai region, along with Sassoon Dock further south and Versova in the northern suburbs. The 176-year-old fish market has stood witness to several generations of fishing families and the Mumbaikars.

### Bhaucha Dhakka fish market

Along with Sassoon Dock (SD), NFW is Maharashtra's largest fish landing centre. Over the years, a system has evolved wherein fishing crafts (mostly consisting of single-day trawlers, gillnetters, purse-seiners, and the small motorized FRP boats) registered in the fishing villages of South Mumbai (Colaba, Cuffe Parade, *etc.*) and in Raigarh district across the bay land their catch in SD, while the large multi-day trawlers, registered in the central and suburban Mumbai (Mahim, Khar Danda, Versova, *etc.*) land their catch in NFW/BD. The majority of these multi-day trawlers are owned by Gujarati-speaking fishers who have been residing and trading in the then-divided United Bombay State, which in 1960 became two separate states of Maharashtra and Gujarat. The two landing centres are located nearby, and their location offers them a distinct market advantage. However, they both have limited birthing capacity. As per Maharashtra's MFRA, only boats registered in the state are permitted to land their catch in the State. Gujarati-speaking trawl owners, mostly hailing from the south Gujarat region, who found the Mumbai market as closer and as one offering better prices, have thus continued to find ways to become integrated with the Mumbai fishing villages (especially Mahim) over the years and now have registered their trawlers in Maharashtra. To resolve conflicts arising from competition to land the growing number of mechanized boats in the region, the present system has come into place through negotiated and protracted but unwritten settlements over the years where different categories of boats land in SD and NFW. A small number of deep sea fishing vessels operated by the far away Tamil Nadu fishers, who specialize in elasmobranch and tuna fisheries also land their catch at NFW.

A tiny bridge connects the mainland and the jetty, and the NFW harbour provides services such as a diesel bunk and an auction hall for the vessels that use it. It is also used as a transit jetty in addition to being a landing centre. The Mumbai Port Trust (MPT)

manages and maintains the NFW fishing harbour, and collects rent from the landing boats. Typically, a fisherman in Bahucha Dhakka starts early in the morning, before sunrise, with the market opening at 4:00 am when the arrival of the catch by motorised and mechanised boats begins and runs until 1.00 pm, with different timing for local sales (4.00 to 9.00 am) and export sales (9.00 am to 1.00 pm). The market's busiest hours are from 5.00 am to 11:00 am. Peak days are Wednesdays, Fridays, Saturdays, and Sundays, when local demand is higher, while Mondays, Tuesdays, and Thursdays are lean days when many locals do not consume meat including fish. Unlike Sassoon Dock, NFW does not have an ice factory, and hence ice is brought from the outside, mainly from Vashi (Navi Mumbai). The three major fish landing centres/markets in Mumbai (BD/NFW, SD and Versova) handle over 1.5 lakh tonnes of seafood each year. On average, Bhaucha Dhakka handles roughly 200 tonnes of fish (Devi *et al.*, 2018).

## Results and discussion

### Fishing details

The NFW/BD fish landing cum market centre is dominated by shrimp trawlers. The fishermen normally go in a crew of 7 to 9 people led by the *Tandel*, the captain. The number of fishing trips in a month varied from 1 to 3 depending on the species caught with a typical trawl fishing trip consisting of 7 to 15 days duration. The most common fishing gear in Bhaucha Dhakka are trawlers and dol netters. The fishing ground for these trawlers extends from the south of the Saurashtra (Gujarat) coast to the Ratnagiri coast, which is around 25,000 square kilometres (Mane and Sundaram, 2011). On the coast, trawlers operate over 40 meters in depth. A total of 1125 trawlers were registered for landing at NFW in 2018 (DoF- Government of Maharashtra, 2018).

### Current marketing practices

#### Fish handling and hygiene practices

Most of the fish is unloaded directly onto the pier by hand. The place is heavily crowded and swarms with people with hardly any space to even freely move around during peak hours of operation. Fish is auctioned in the open platform of the dock itself which is then packaged and transported to other places namely processing industries, wholesale and retail markets. During the processes of unloading, auctioning and packaging, the fish is handled roughly with little attention to possible damage, quality and hygiene. The unloading of fish from boats is done by both men and women. Fishes are often washed with the visibly muddy, polluted, and possibly contaminated water is drawn from the sea at the harbour/landing site. In the fish market, there is no adequate water supply. Before being sold, the fishes are

placed directly on the pier concrete and showered with water to improve their appearance. Harbor water is frequently used to clean the equipment, containers, and pallets.

#### Fish auctioning and handling logistics

Auctions are not always held in the designated auction hall, which is rather small considering the landings. Large-size fishes are handled over from the boat to the auction area mostly by hand, while the smaller-size fishes are handled in plastic crates by men and in bamboo baskets by women. Auctioning / selling happens directly from the pier/concrete floor. Auctioning goes on for far too long beginning at 5 am and concluding only around 9 am. Interestingly, weighing balances are not permitted till the auction is concluded, after which it is used by the buyers while transporting it further. Thus, the landing centre, at the wee hours of every morning, brims with a large number of fishers, crew, wholesale and retail buyers, labour engaged in loading and unloading, and the fleet of transport vehicles. Passenger vehicles are not permitted to enter the market area though. Only hand-drawn wooden carts are used/permitted to ferry the fishes from the auction area to the transport vehicles parked at the edge of the market area.

#### Marketing channels

According to Mendoza (1995), a marketing channel may be defined as the path traversed by the commodity (fish) as it moves from the producer to the consumer. Five forms of marketing channels were observed in the Bhaucha Dhakka fish market, depending primarily on the auction time. Two channels (1 and 5 below) are the most prominent channels. Channels 1, 2, 3 & 4 can be found during the early hours from 4 am till 9 am when the sale consists primarily of relatively low-value small-size fish meant for local/domestic markets. Weighing instruments are not permitted at the market during this time, and manual segregation and auctioning are the only options. After 9 am, the high-value and large-size fish are marketed through the marketing channel 5, described below wherein the fish is meant for the distant export markets and the high-end hotel segments. This indicates preliminary species and size-based sorting and grading at the fishing crafts itself.

#### Before 9.00 am

Channel 1 - Fishers → Auctioneer → Wholesaler → Retailers → Consumers

Channel 2 - Fishers → Auctioneer → Wholesaler → Consumers

Channel 3 - Fishers → Auctioneer → Retailers → Consumers

Channel 4 - Fishers → Auctioneer → Consumers

### After 9:00 am

Channel 5 - Fishers → Auctioneer → Supplier → Processors → Export

### Fish species landings

Bhaucha Dhakka alone contributes 45% of marine fish landings in Mumbai *i.e.* 68,000 tons in 2018 (DoF - Government of Maharashtra). Since 2014, fish landings have steadily increased at BD (Fig. 3). The dominant pelagic, demersal, and crustacean species observed in the BD fish landing cum fish market are listed in Tables 1,2 & 3.

### Fish market infrastructure quality index (FMIQI)

Based on the FAO's market infrastructure quality checklist described above, the FMIQI index score for Bhaucha Dhakka was found to be only 28% which categorises the market as *poor*. Hygiene and cleaning aspects need drastic improvement in BD, which is classified as *very poor* (18%). Only the product quality index (56%) was found to be comparatively better (*fair*) in BD, with both the reception/landing area quality and design of premises falling in the *poor* category (Table 4). The description of the market and the marketing practices above justifies the FMIQI ranking. The study by Bunkar *et al.* (2023) also indicated the fish market infrastructure quality in major fish markets in Haryana and Punjab. The product quality index is almost fair (50-63%) in all the fish markets. The BD fish market's FMIQI (28%) is aligned with Sikendrapur fish market, Gurugram (23%), Matshya fish mandi, Faridabad (31%), and

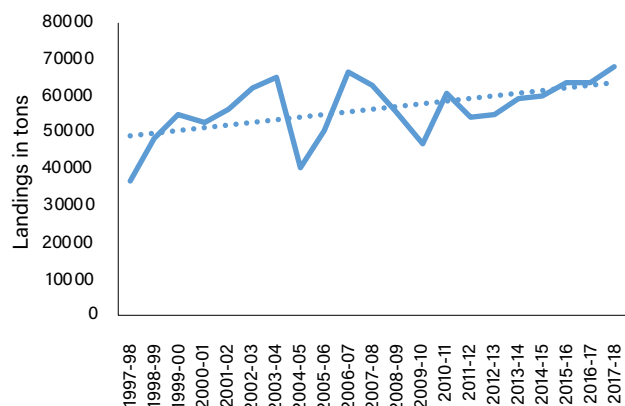


Fig. 3. Fish Landings Pattern 1998-2018 Data source: DoF, Government of Maharashtra, 2018

Table 1. Major pelagic fishes

Scientific Name	Common name	Vernacular name
<i>Lactarius lactarius</i>	False trevally	Saundalo / parava
<i>Johnius dussumieri</i>	Croaker	Dhoma
<i>Coilia dussumieri</i>	Anchoviella	Mandeli
<i>Sardinella longiceps</i>	Sardines	Padwa/pedvey
<i>Scomneromorus guttatus</i>	Seer fish	Surmai
<i>Rastrelliger kanagurta</i>	Mackerel	Bangada
<i>Harpodon neherus</i>	Bombay duck	Bombil
<i>Hilsa ilisha</i>	Hilsa / Herrings	Pala
<i>Auxis thazard</i>	Tuna / frigate tuna	Kupa

Table 2. Major demersal fin fishes

Scientific Name	Common name	Vernacular name
<i>Lepturacanthus savala</i>	Ribbon fish	Bala
<i>Pampus argenteus</i>	Silver Pomfret	Chandava
<i>Parastromateus niger</i>	Black pomfret	Halwa
<i>Cynoglossus lingua</i>	Tongue sole	Lepa
<i>Etheronema tetradactylum</i>	Polynemids	Rawas/ Dara
<i>Lutjanus johnii</i>	Snapper	Tambusa

Table 3. Major crustaceans

Scientific name	Common name	Vernacular name
<i>Penaeus indicus</i>	Penaeid prawns	Kolambi
<i>Panulirus polyphagus</i>	Lobsters	Shevand
<i>Teuthida</i>	Squids	Mhakul
<i>Portunus sanguinolentus</i>	Crabs	Kenkada

Table 4. FMIQI of Bhaucha Dhakka Fish Market

	Infrastructure dimensions / Sub-indices	Score		Status
A	Reception/landing area quality index	9/32	28%	Poor
B	Design of premises index	16/56	29%	Poor
C	Hygiene and cleaning index	10/56	18%	Very Poor
D	Product quality index	9/16	56%	Fair
	FMIQI of Bhaucha Dhakka fish market	44/160	28%	Poor

Amristar fish market (31%), which is *poor*. In contrast, the Jalandhar fish market (43%) and Tajpur fish market, Ludhiana (55%) are categorized as fair. Therefore, there is an urgent need for targeted interventions to enhance the infrastructure of the Bhaucha Dhakka fish market. Improving reception/landing areas, upgrading premises design, ensuring better hygiene practices, and maintaining high product quality are imperative to enhancing market competitiveness and consumer satisfaction.

### Impact of COVID-19 pandemic on fishers/fish

In India, COVID-19-induced shutdown and restrictions happened in two phases, as in many other countries. The

first phase lasted from March 24 to April 14, 2020, and a complete lockdown was imposed with severe movement limitations. There were no fishing activities, and several vessels were left stranded in fishing harbours. During the second phase (from April 14, 2020 onwards), the government relaxed certain restrictions and permitted fishing activities to some extent. As the movement restrictions disrupted the supply chain logistics in the fisheries sector as well, fishermen were obliged to sell their catches at low prices as the perishable nature of the fish commodity offered them no other option but to sell at a lower price. Already being in debt forced the fishermen to borrow more from the local money lender at a high interest rate, further pushing them into a debt trap. Access to formal institutional lending has always remained low among fishers, the lack of bankable assets as collaterals being one of the cited reasons. Because of COVID-19 fear, several fishers did not go fishing, remained unemployed, and even lost family members.

The sudden nature of the pandemic pushed especially the small-scale fishers and fish workers into a vicious cycle of un(der)employment and debt trap. Avtar *et al.* (2021) indicated that regular fishing activities came to a standstill for almost ten weeks, spanning from March to May 2020. Subsequently, fishing operations faced continued disruptions for an additional three months (June to August) due to restrictions imposed during the monsoon season. Fishermen, fish labourers, and other actors in the fisheries value chain faced several occupational challenges. Their lives got tougher during the crisis than previously. Consumer attitudes about seafood purchases have also shifted, pulling down the market price (Mandal *et al.*, 2021).

### Diesel price and subsidy during lockdown

The Maharashtra government offers reimbursement of state tax on the fuel (diesel) price to the tune of Rs.1.50 per litre to the registered fishing vessels. However, the quantity of fuel eligible for reimbursement as well as the extent of reimbursement varies across states. For instance, the Andhra Pradesh government offers a tax reimbursement on diesel to the extent of Rs. 9 per litre, with a ceiling of up to 3000

litres a month for 10 months for each mechanized boat, and 300 litres for motorized boats. During the lockdown, diesel costs rose steadily due to disruptions in the supply chain across the world especially in oil import-dependent countries like India. Lack of commensurate increase in diesel subsidy increased fuel cost for fishers. Most of the informants stated that government assistance during and after COVID-19 pandemic was insufficient to support their families and fishing operations.

### Price spread in fish market

The difference between the price paid by consumers and the price obtained by fishermen is known as the price spread. The larger the share of fishers, the lower the price spread; the higher the share of fishers, the higher the marketing efficiency. The price spread was found to be greater in low-valued species (such as croakers and anchovies) and lesser in high-valued species (like lobsters and Penaeid prawns). For popular fish species such as anchovies, seer fish, pomfret, Bombay duck, and shrimps, the price spread ranged from 16% to 50%, indicating *moderate to poor* marketing efficiency. However, what was evident was that the price spread *widened* for all species *after* the lockdown (Table 5&6). This widening of the price spread can be attributed to a rise in costs due to labour shortage as well as transportation and movement restrictions. Similarly, the European market *also* highlighted that the price had declined by 20–70% for their Mediterranean fisheries (OCDE, 2020), and also the price of Hilsa fish (*Tenualosa ilisha*) in Bangladesh decreased by 6–13% (Mamun and Pounds, 2021).

### Performance of fishing output before and after COVID-19 lockdown

Ice, fuel, and labour are the three most expensive items, accounting for more than 90% of the total cost. On average, eight crew members were found to work in each fishing vessel. In some cases, family members also work in various fishing activities. An average of 17 tons of crushed ice was being used per trip which was priced at ₹1700 per tonne.

Table 5. Price spread & fisher's share before lockdown

Species	Fisher's price INR/kg	Consumer price INR/kg	Average Price spread (INR/kg)	Average Price spread (%)	Fishers' share (%)
Anchovies	50-70	90-130	50	46	54
Pomfret	500-1400	900-1900	450	32	68
Seer fish	550-600	700-800	175	23	77
Mackerel	150-300	200-400	75	25	75
Bombay duck	110-160	170-200	50	27	73
Lobsters	800-1000	900-1300	200	19	82
Penaeid prawns	300-700	400-800	100	17	83
Croaker	60-90	120-180	75	50	50

Table 6. Price spread and fisher's share after lockdown

Species	Fisher's price INR/kg	Consumer price INR/kg	Average price spread (INR/kg)	Average Price spread (%)	Fishers' share (%)
Anchovies	45-70	100-150	67	53.6	46.4
Pomfret	400-1300	1200-1800	650	43.3	60.7
Seer fish	450-550	700-800	250	33.3	66.7
Mackerel	120-250	210-400	120	39.4	60.6
Bombay duck	140-180	180-280	70	30	69.5
Lobsters	500-900	950-1300	425	37.8	63.6
Penaeid prawns	250-600	400-800	175	29.7	70.8
Croaker	40-70	130-180	100	64.5	36

Before the lockdown, fishers at BD earned an average net income of ₹49,108 per month, which *declined* by 31% (₹33,819) *after* the lockdown. The total fishing cost had increased by 10.8% as a result of the COVID-19 regulations. The cost of fuel (23%), labour (9.6%), and food (8.6%) are the important costs that increased after the lockdown. Meanwhile, docking and registration fees remained unchanged during these two periods (Table 7). As stated above, the COVID-19 pandemic on the other hand led to a decline in fishermen's income due to lower fish prices compared to pre-pandemic levels. A study found that the mean overall economic impact resulting from the loss of investments and operating costs during the initial months of the pandemic on marine recreational fishing in 15 countries was estimated at € 504.74 ± 1244.05 per fisher (Pita *et al.*, 2021). In the Indramayu district of Indonesia, fishermen experienced a decrease in income ranging from 20% to 30% per trip (Sari *et al.*, 2021). Similarly, the pandemic negatively affected the income of fishery stakeholders and their livelihoods, experiencing a 47.49% decrease in income in 2020 compared to the base year of 2019 (Shamsuddin *et al.*, 2023).

### Constraints faced by fishers during lockdown

Though COVID-19 did not directly affect seafood catch, it impacted transportation and supply chain operations, resulting

in higher fuel and labour costs as well as a lack of buyers, resulting in lower fish prices. Not only fishermen but also wholesalers, retailers, and other parts of the seafood value chain were also affected due to COVID-19. Sudden illness, reduced income, loss of family members, lack of alternative revenue generation, shortage of labour, lack of transportation, *poor* consumer demand, rising commodity costs, creditor pressure, and payment delays were reported by fishers as constraints and difficulties faced by fishermen during the lockdown. Some studies have already reported similar constraints. Low fishing rate, low income, lack of alternative income-generating activities, weak value chain, and steady rise in lockdown days are all important constraints experienced by fishers during lockdown (Sunny *et al.*, 2020). The involvement of the middleman further complicated the situation. It was observed that 88.5% of fishermen at BD relied only on fishing for their livelihood, making them more vulnerable to the COVID-19 epidemic. Every month on the first, the Mumbai Port Trust (MPT) collects port dues. As a result, even if the vessel comes on the last day (30th) of the month and departs on the first day (1st) of the next, it must pay for two months.

### Conclusion

The proportion of the price that goes to the fishermen varied from species to species, but it was relatively higher

Table 7. Fishing cost and net returns before and after lockdown

Particulars	Before lockdown (INR/month)	After lockdown (INR/month)	% Change
Fuel	50000	61500	23.0
Ice	50500	52500	4.0
Labour	142320	156000	9.6
Food	8932	9698	8.6
Docking charges (Rs.25000/year)	2083	2083	0.0
Maintenance of gear & craft (Rs. 30000/year)	2500	2600	4.0
Auctioning (2% of total sale)	6257	6500	3.9
Registration in MPT	300	300	0.0
Total cost/Expenses	262892	291181	10.8
Gross returns/Income	312000	325000	4.2
Net returns/Savings	49108	33819	-31.1



for low-value fish. Price in the BD market is influenced by several variables, including supply, demand, fish size, quality, grade, consumer bargaining power, and wholesaler/retailer participation. Supply chain restrictions during the lockdown, and the higher livelihood dependency of marine fishers on fishing deeply affected and changed the supply-demand dynamics in the marine fishing sector. After the lockdown, the consumer rupee share of fishermen fell as a result of an increase in cost and the fall in fish market prices. Fishermen from Bhaucha Dhakka suffered a nearly 31% (IN ₹ 15,289/month (USD~181)) decrease in net returns as a result of additional restrictions. Moreover, the pandemic has brought to the fore the *poor* infrastructure quality at the Bhaucha Dhakka landing centre as the low FMIQI score revealed in terms of infrastructure, cleanliness, and product quality. While specific interventions like the use of pallets or containers during the auction to increase market cleanliness, using ice to lower the temperature and shortening the auction duration, etc. may improve the hygiene and quality of fish, the BD market needs a major transformation. Modernising the market with the integration of market, infrastructure, and support services under one roof is required to improve its structure, conduct, and performance. It was found that only a few consumers were found adhering to COVID-19-appropriate behaviour. Now that COVID-19 is past, the lessons learned during and after the pandemic concerning fish markets, both domestic and export, need to be synthesised drawing insights to modernize markets and transform the value chain in the fisheries sector.

## Acknowledgements

The authors are thankful to ICAR- Central Institute of Fisheries Education for providing the necessary facilities for this study.

## Author contributions

Conceptualization: PSA; Methodology: PSA; Data collection: PS, TM; Data analysis: PS, SN; Writing original draft: PS; Writing review and editing: PSA, ALK, SN, TM; Supervision: PSA, ALK

## Data availability

The data are available and can be requested from the corresponding author.

## Conflict of interests

The authors declare that they have no conflict of financial or non-financial interests that could have influenced the outcome or interpretation of the results.

## Ethical statement

No ethical approval is required as the study does not include activities that require ethical approval or involve protected organisms/ human subjects/ collection of sensitive samples/ protected environments.

## Funding

No funding was received for the study.

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