

# Anticipating the impact of the COVID-19 lockdowns on the Indian fisheries sector for technological and policy reforms

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*The lockdowns imposed to contain the COVID-19 spread had an indisputably cascading effect on the aquaculture industry across the globe. It has adversely impacted the Indian fisheries sector through changing purchaser demand, supply chain disruptions, trade restrictions, and also the livelihood of millions dependent on it. However, the consequential reduced fishing will also likely help in replenishment of the aquatic biodiversity and provide the balance needed in the long-term sustenance of the fisheries sector. The technological and policy interventions in pre- and post-harvest fisheries operations are anticipated to reduce some of these negative impacts in similar lockdown scenarios.*

**Keywords:** Aquaculture, COVID-19 lockdown, fisheries sector, policy reforms, technological interventions.

THE world is currently witnessing the worst public health crisis in recent history, with the COVID-19 pandemic affecting many sectors, including fisheries. All nations have been experiencing the rapid spread of COVID-19 infection. India's sudden response to contain the pandemic with a lockdown across the country from 24 March 2020 for more than 50 days, stopping all non-essential activities and transport, scored a perfect 100 in the 'stringency index' developed by researchers at University of Oxford, UK. However, under this emergency with an uncertain ending, the Government of India, exempted agriculture-farming and allied activities from lockdown by classifying it under essential category. Therefore, the negative impact will likely be low on agri-food sector<sup>1</sup>. The coronavirus disease is not known to infect aquatic animals used as food or contaminate their products<sup>2</sup>. However, the sector is influenced by the indirect effects of the pandemic, primarily due to reduced consumer demand, restricted market access, logistic issues related to transportation and border restrictions<sup>3</sup>. These restrictions have negatively impacted fisheries and aquaculture unit operations from seed and feed supply, processing aspects, export, fish recruitment, aquatic ecosystem, population nutrition

gross domestic product (GDP) and livelihoods of millions of people dependent on it. This article summarizes the existing and anticipated impacts of COVID-19 lockdowns on the fisheries sector of India, and also the technological interventions and policy reforms for preparedness under similar lockdown scenarios.

## Livelihood of fishermen communities

Fisheries in India is a sunrise sector with varied resources and potential, engaging over 14.5 million people directly at the primary level and many more along the value chain, of which 80% are small-scale fishers. The share of the fisheries sector in India's GDP is about 1.03%. It accounts for about 6.58% share of India's GDP<sup>4</sup>. Agricultural workers experience the highest incidence of working poverty affecting extremely almost a quarter of the workforce. Despite playing an important role in the national economy, providing a link with the global structures of agricultural production and trade and feeding the world, many agricultural workers and their families suffer from poverty and food insecurity<sup>5</sup>. In India, fish production has seen a decline in recent years<sup>6</sup> and is anticipated to continue as a side effect of the COVID-19 pandemic. The fishermen community, fish vendors and fishing labourers are being affected economically, particularly due to market closures. Complete lockdown in the harbours and landing centres has greatly impacted the fisherfolks in their day-to-day earnings and employments. The situation is expected to worsen after the lockdown since it would be followed by the annual fishing ban (15 April to 31

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May along the east coast and 15 June to 31 July along the west coast of India) to protect fishery resources and biodiversity during the breeding season. As a result, marine fishermen effectively will not be fishing many more days in this year. This will directly reduce the total fish production and lead to a secondary, indirect, or cumulative effect on supply and demand of fish and fish foods.

The fisherfolk families mostly include daily-wage earners. In India, of the total population of 5.4 million active fishers, 3.8 million are fishermen and 1.6 million are fisherwomen. The fisherwomen are engaged in several important activities of the fisheries industry right from fishing jetty till the fish reaches the buyer's table<sup>7</sup>. The decline in catch of fish and drastically diminished market demand due to lockdown restrictions have reduced the number of wage days of fishermen, particularly the supplemental income generated by the fisherwomen to support their families. Since most of fishermen are less perceptive about modern capture fisheries techniques and totally depend on fishing with traditional gear and craft<sup>8</sup>, the current lockdown effects will displace fishermen to other remunerative work opportunities. Though the government departments and concerned research institutions have offered advisories on suitable work practices emphasizing the do's and don'ts for fishers and aquaculture farmers, hatcheries and markets to contain the COVID-19 spread, these seem inadequate to reduce the labour workforce displacement from fisheries sector under extending pandemic duration.

### Aquaculture

In India, the demand for fish is driven by the food service industry, as well as huge retail or village markets situated especially in the urban areas connected by road and rail. The sudden dip in demand for fish has brought in focus the vulnerability of the aquaculture market to such unexpected closures. Freshwater aquaculture sector, especially in Andhra Pradesh and West Bengal, is worst hit by this supply chain disturbance. It had ready marketable fish stocks, but was unable to send it to the market. Furthermore, the emergence of COVID-19 pandemic from a wet market in Wuhan Province of China, that sells fish as well, has been fuelling aversion towards consumption of non-vegetarian food, including fish. The association of the Wuhan wet market with the COVID-19 pandemic is likely the major factor resulting in the decline of fish demand, though no scientific study has proven the spread of COVID-19 through fish or fish-based products<sup>2</sup>.

The in-built resilience of fish to survive at their culture sites without being exclusively fed for longer duration, allowed delayed harvesting and thus shielded to some extent, the unprecedented losses that generally occur in case of perishable commodities. However, the additional feed needed for survival increases the FCR (food conversion ratio) above the planned optimum levels, thereby re-

ducing profitability. The cost of fish feed production is likely to increase in future, since the supply of raw materials like corn, soya, de-oiled rice bran and mustard cake will be disturbed in the after-effect of the pandemic. Quantification of the change in economies of all affected sectors from seed to feed would remain uncertain, which will pose a situation for decision-making on FCR and choice of feed. The future will be redefined the way in which aquaculture has to be carried out.

### Fish seed production and supply

In India, the peak months for stocking of seed in the ponds by farmers begin from April. The hatcheries too are at their pre-management of production during this period. Due to closed state borders during lockdown and uncertainty of normal functioning, the transportation of fish seed from West Bengal and other parts of India has been seriously affected. Many hatcheries had produced fish seed before lockdown and were awaiting transportation facilities. The Government of India launched 'Kisan Rath' mobile app to facilitate the transportation of agricultural produce during the lockdown period, and it is picking up momentum. Such transporter aggregator apps, though the best digital initiative possible during such lockdowns, will only partially absorb the negative impact on transportation facilities. A huge gap is therefore anticipated in the demand and supply of fish seed. According to the All India Shrimp Hatcheries Association, a large number of seeds have been destroyed during the lockdown, with an estimated loss of 15,000 broodstocks and 3.5 billion seeds due to limited life of only 2–3 days. Many hatcheries produce pangasius and tilapia seeds to meet the need of cage culture, which currently stocks just 10–15% of seed, leaving hatcheries with stocks that have no customers because to restriction in transportation. Inland aquaculture mostly depends on Indian major carp seed, which starts from June and onwards. However, the pre-breeding management, viz. monitoring the quantity and quality of brooders, maintenance of hatchery, preparation of nursery pond, etc. is affected due to non-availability and displaced labour workforce.

### Ornamental fish industries

In 2016, the Indian ornamental fish industry was US\$ 1.06 million and it contributed 0.3% of the total export<sup>9</sup>. The ornamental fish industry provides jobs to around 50,000 people through 5000 aquarium retail outlets and an equal number of production units<sup>10</sup>. Mumbai, Chennai, Delhi and Bengaluru are the major consumer cities and backbone of ornamental fish industries. Since these were totally shutdown during the pandemic, the ornamental fish industry has been worst hit due to the lack of demand. In ornamental fish retail industry, live food is the single

important item that influences the operational cost. The success and running of aquarium fish breeding and culture units depend upon constant supply of live food in the vicinity<sup>11</sup>. Due to disturbed supply chain and demand, the ornamental fish industry has to readjust its production rates for profitability.

### Supply chain disruption

Logistic challenges within supply chains, particularly cross-border and domestic restrictions of movement, as well as labour issues may lead to disruptions in food supply, especially if they remain in place for a longer duration<sup>3</sup>. Fish and shrimp have been exempted from the lockdown after they were included in the list of essential services. Though these provisions seem to ease the burden on fish and shrimp industry, the lockdown has disturbed the supply chain. The exemptions and their implementation are yet to address the complexities of the production and supply chain, such as regular requirement of ice, farming equipment, food supplements, fish meal, etc.

Fish and other aquatic foods are a key part of the global food systems and a highly nutritious food group of major social, cultural and economic significance. Disruptions in the supply chain for fish and aquatic foods are already happening due to disruptions in transportation, trade and labour. Falling production from reduced fishing efforts and delayed stocking of aquaculture systems will lead to low supply, access and consumption of these foods. Decreased consumer demand and increased transaction costs will have a knock-on effect that will increase the price of fish and aquatic foods and make them less affordable to the poor consumers. Many people employed in these supply chains, such as fish vendors, processors, suppliers or transport workers will lose their jobs<sup>12</sup>.

Due to restriction on market access, drop in demand and disrupted demand and supply chain, fish and fish products need to be stored for longer duration. In the disturbed production capacities of ice and its transportation, preserving the harvest will be challenging. The supply chain for ice should be strengthened with app-based ecosystem connecting consumers and suppliers. In the absence of fish workers, tasks such as loading and unloading of fish, transport of stock and ice, and other jobs that are labour-intensive and integral to the supply chain, are likely to be drastically affected. The fisherfolk returning from the sea need alternative arrangements for fish processing and further storage due to reduced demand. This situation will likely force them to sell their catch at less profit, in the absence of alternative storage arrangements. Also, the allied activities like net mending, regular maintenance of boats and engines will be affected, and are likely to cause repair and maintenance-related penalties to the high-cost assets like fishing crafts and gears.

### Import–export

As part of the supply and demand chain, India's seafood trade will also be influenced by disruption caused in import and export sector by the fast-spreading COVID-19 pandemic and suspension of major transportation routes. Shrimp is India's single biggest export commodity amongst all fisheries commodities. It is the most traded fishery product worldwide. More than 90% of Indian shrimp produce is exported, the major destinations being USA and China<sup>13</sup>, which incidentally are among the worst affected countries by the pandemic. Although India has been the major shrimp exporter in the past decade, its broodstock is imported. India imported specific pathogen-free (SPF) *Litopenaeus vannamei* broodstock (98% of total Indian broodstock imports) in 2015. In addition to broodstock, Artemia cysts, which are used as live feed for shrimp larvae are also imported<sup>13</sup>. Shipments to China, Europe and the Far East have reduced. The exporters will also face problems in the US, the top market for Indian seafood. In 2018, India exported 1,377,244 MT of seafood worth US\$ 7.08 billion and ornamental fish export touched US\$ 1.32 (ref. 14). The global uncertainties in the demand and supply chain will discourage taking up any associated activities by the workforce involved in these chains, thereby leading to increase of inflation across all sectors.

### Replenishment of fish biodiversity

During the last few decades of anthropogenic activity, the marine environments have perished due to overfishing and subsequent decline in biodiversity<sup>15</sup>, particularly fisheries stocks have collapsed. The continuous fishing reduces the abundance, spawning potential, growth and maturation of the target resources as well as of their associated and dependent species<sup>16</sup>. The fishing ban improves substantially the health status of the fish assemblage. However, since the fishing closure in any given water body creates localized areas of higher biomass and size distributions of larger fish relative to the fishing ground<sup>17–19</sup>, the current closure will help in the conservation and stock enhancement of aquatic species in India. The lockdown and restricted fishing activities are helping in the rebuilding and revamping of fish populations and their ecosystems. Models of fish replenishment almost invariably assume that fish reproduction scales isometrically with biomass; that is, if fish mass increases by 10%, there will be a proportionate 10% increase in its reproductive output<sup>20,21</sup>. The meta analysis showed that the absence of fishing activity allowed 28% longer growth of fish as compared to those in exploited fishing ground<sup>17</sup>. Restriction due to ban on fishing helps in the replenishment of exploited habitats and is linked to all trophic levels directly leading to

increase in productivity and biodiversity of aquatic ecosystems.

### Fish recruitments

Fish recruitment refers to the process of small, young fish transitioning to an older, larger life stage and is probably the most important process that regulates populations of fish. The national lockdown will help the recruitment of numerous fishes, shellfishes, including IUCN Red-listed species, owing to its coinciding reproducing period, that annually gets affected by the fishing activity during the same period. India contributes 90% of the world mackerel production, which is a major fishery resource in the Indian marine fisheries sector. The spawning of Indian mackerel, sardine, threadfin bream, cephalopods, tunas, seerfish, sciaenids and other commercial fishes occurs during February to June<sup>22-27</sup> and has a significant role in the reproduction and enhancement of the fisheries stock. Species protecting key spawning or nursery areas of vulnerable species can also be highly effective for stock enhancement<sup>28</sup>. Since fishing and other human activities are restricted, this allows depleted populations to recover while protecting key species and vulnerable habitats.

### Technological and policy interventions for preparedness under future lockdown scenarios

The opportunities that arise to adopt technological innovations and improve environmental sustainability should not be missed<sup>5</sup>. The incidence of COVID-19 has exposed the vulnerability of the informal labour sector and reverse migration is a clear indicator of the same. The closure of non-essential economic activities and restrictions on movement have destabilized the labour market, at least in the short run. The non-availability of labour workforce, the disconnected consumers and their uncertain demand of fisheries products are the weak links responsible for destabilizing the demand–supply balance in the fisheries sector. Even if the COVID-19 scenario is rare, there are several lessons to be learnt for preparedness in any anticipated or unanticipated similar scenarios. The following listed technological interventions may be adopted by the fisheries sector or considered for appropriate policy reforms and prioritization of research projects for preparedness and reducing negative impacts in similar lockdown scenarios.

#### *Fish seed production and supply*

(1) Establish and train localized farmer clusters for seed production and supply. (2) Develop app-based ecosystem to connect seed suppliers and fish growers with in-built mechanisms for fish counting, transportation facilities and feedback mechanism.

#### *Fish feed production and its supply*

(1) Develop app-based ecosystem to connect feed suppliers and fish growers with modified feeding tables for faster growth and reducing stocking time.

#### *Cage culture production systems*

(1) Automate the on-site monitoring and feeding operation with Internet of Things (IOT)-connected surveillance system and automatic feeders to reduce dependence on labour workforce. (2) Develop robust and low-cost fish biomass estimation methods for cage culture to enable informed decision-making on feeding regimes during reduced market demand and subsequent harvest scheduling. (3) Develop/deploy on-site fish cleaning, packaging and cold-storage facilities for valuable cultured fish species for easy transportation and sale with app-driven B2C business model.

#### *Fish retail market*

(1) Develop app for connecting fish farmers/suppliers directly to consumers for higher productivity, profitability and to reduce storage-related shortcomings.

Formulation of policy reforms requires collective cognizance of domain experts. Therefore, ratings on a seven-point scale were invited from fisheries experts from national and state fisheries departments, postgraduate teachers, fisheries industry and progressive farmers based on priority, ease of implementation and perceived impact. These rational ratings by 20 selected experts were filtered to calculate the cumulative scores (Table 1).

The policy reforms grouped as ‘A’ were adjudged the immediate priority, whereas those with decreasing cumulative scores were grouped as ‘B’ and ‘C’. Surprisingly, the policy reforms of simplified insurance schemes and developing fair pricing mechanism for fisheries commodities had less cumulative score. This is due to the perception of experts that simplified insurance schemes for fisheries sector will not have a significant impact while fair pricing mechanism for fisheries commodities will not be easy to implement, and therefore had a lower cumulative score.

### Conclusion

The fish and fishery products are particularly dependent on the demand chain and thus are highly affected by changes in the food service industry. As India implemented lockdown measures for all non-essential activities, restaurants, ice factories, processing units, feed units and seed units were negatively impacted on economic and social fronts. The technological interventions suggested for simplified decision-making, automation in pre- and

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**Table 1.** Cumulative priority ranking of policy reforms by invited fisheries experts

Group	Reforms	Priority	Ease of implementation	Perceived impact	Cumulative score
A	Policy measures to bring aquaculture industry under essential and priority sector (to support transportation of inputs, marketing, processing, import and export activities).	125	112	110	347
	Creating modernized hygienic fish marketing hubs in potential zones.	122	108	110	340
B	Promotion of biofloc and recirculatory aquaculture systems (RAS) for enhancing resilience.	112	111	108	331
	Digitized tools for e-governance (licencing of fisheries stakeholders and traceability of produce).	120	105	106	331
	Value addition: promoting techniques to enhance the shelf life of fish and fish products.	125	105	101	331
	Promotion of domestic market by increasing awareness about safety of consumption of fish products (through ICT awareness campaigns/KVK/radio/advertisement, etc.).	126	105	100	331
	Mechanism for door-step delivery of fisheries input (seed, feed, medicines, etc.).	126	100	104	330
	Establishment and organization (FFPO) strengthening of fish farmers producer	120	101	106	327
	Development and promotion of e-commerce platform like eSanta for eliminating middlemen.	119	103	103	325
C	Simplified insurance schemes for fisheries sector.	118	103	98	319
	Developing fair pricing mechanism for fisheries commodities (similar to MSP in agriculture).	114	97	104	315

post-harvest fisheries activities, particularly using IOT-based solutions wherever possible, are anticipated to reduce the negative impacts under similar lockdown conditions in the future. Also, the policy interventions, viz. to bring aquaculture industry under essential and priority sector (to support transportation of inputs, marketing, processing, import and export activities), and setting up modernized, hygienic, fish marketing hubs in potential zones are priority steps to be taken towards preparedness against similar lockdown scenarios. At the positive end, the slow pace of fishing activities is anticipated to help in the replenishment of aquatic biodiversity and provide the balance needed in sustenance of fisheries sector in the long term.

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