

Impacts of COVID-19 on small-scale freshwater carp and coastal brackish water shrimp farming in India

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Abstract – The present study was simultaneously conducted in two distantly located areas to assess the impacts of COVID-19 on farming processes, instantaneous financial impacts and mitigation strategies adopted by the farmers in the small scale freshwater carp farming and coastal brackish water shrimp farming sectors in India. Primary data were collected through interview of the farmers with the help of pre-tested structured interview schedules. Though the initial impact in both the sectors were substantial, freshwater carp farmers mitigated the crises comparatively well because of wider option in alternative livelihood, low cost locally available inputs, mobilization of local market, direct door to door vending of live fish and mobilization of women work force from the family in the farming sector. Untapped resource in the form of women's participation in the freshwater farming practices was noteworthy during the pandemic period which increased polynomially ($y = -1.0714x^2 + 7.5286x - 2.2$; $R^2 = 0.9648$). As the shrimp farming sector was dependent upon external markets and burdened with high cost inputs primarily supplied by the input dealers on credit basis, the sector has to bear the burden most. Garret's Rank analysis revealed that integration with other production sectors ranked first as mitigation perception to the freshwater carp farmers, whereas, to the coastal shrimp farmers, the highest rank was with the perception that everything will be normalized within 2–3 months naturally. Garret's Rank analysis also revealed that in both the sectors, the farmers most important need was credit from the Govt. source in mitigating COVID-19 like crisis in future.

Keywords: COVID-19 / small scale aqua-farming / constraints / mitigation measures / preparedness

1 Introduction

Fisheries and aquaculture continued to act as important sources of nutrition livelihoods for people around the world and specially in the Asian countries. An estimate indicated that sixty million people are directly engaged in fisheries and aquaculture, supporting the livelihoods of 10–12% of the global population (FAO, 2017). Moreover, fisheries and aquaculture produce are vital sources of good quality protein, essential fatty acids, vitamins and minerals important for the cognitive and physical development of human beings (Roos *et al.*, 2006) providing 15% dietary protein of at least 2.9 billion people (FAO, 2008).

Aquaculture makes use of natural resources for the cultured organisms to grow that covered about 18.8 million ha of land worldwide (Waite *et al.*, 2014). World aquaculture is primarily centered in and around the Asia– Pacific region amounting 89% of production in terms of quantity and 79% in

terms of economic value. India's vast coastline of over 7500 km and 2.36 million hectares of ponds and tanks enabled her the second-largest contributor in the global aquaculture market and is home to more than 10 percent of the global fish biodiversity (NABARD, 2018). While several industries were battling the brunt of a global pandemic, India exported over 11 lakh tonnes of seafood in 2020–21 fiscal amidst mounting challenges. With 1.8 million tonnes of inland capture fisheries production, India ranks first globally for the first time in 2022 since the mid-1980 s. The increasing demand for shrimp in the global market coupled with lucrative price prompted more and more farmers to venture into shrimp farming (Patil and Sharma, 2019). In India, most of the finfish production from inland aquaculture goes towards meeting the local and domestic market demand, in contrast to the coastal brackish water sector, where the shrimps being produced are predominantly export market oriented.

COVID-19 outbreak has been declared a public health emergency of international concern by the World Health Organization (WHO) on March 11, 2020 (Hafeez *et al.*, 2019;

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WHO, 2020). During the ongoing pandemic, deadly disease spreads through the human population impacting a sizable amount of individuals in major part of a nation or the entire nation, even a continent or the entire world (Muthu, 2005). Key features of pandemic include wide geographic extension, disease movement, infectiousness, contagiousness novelty, severity, high attack rates, and explosiveness, and minimal population immunity (Qiu *et al.*, 2017).

Small scale aquaculture is the principal source of livelihood, in which the operator has invested substantial livelihood assets in terms of time, labourer, infrastructure and capital. Off-farm nutrient use/farm products (input/output ratio). Providing good quality protein source to poor rural village in a developing country (FAO, 2009). The small scale aquaculture sector both in freshwater and coastal areas like any other sectors of agriculture and animal husbandry has been impacted heavily because of the on-going COVID-19 pandemic. This has created an instantaneous economic downturn in general and created acute problems in the farming process in particular. The farmers had to face the wrath of livelihood constraints, complete or partial halt of their culture practices, harvesting, and marketing their products because of the complete breakdown of marketing channels. As differences in the magnitude of impacts of COVID-19 were noticed in the smaller and larger farms, different coping strategies and requirements of support from the government in order to continue to function were emphasized (Harris *et al.*, 2020). During the pandemic, fishing activities have drastically been reduced both for artisanal and industrial sectors. As per observation of FAO (2020), fishing communities and ports could potentially become “hotspots” for rapid infection due to the migratory nature of fishers and the frequency of international visitors. Comparing with the previous years, global industrial fishing endeavour had fallen about 6.5 percentage during April 2020 because of restrictions and closures associated with COVID-19 (Clavelle, 2020).

During this crisis, it is worth studying how farmers with no prior knowledge and experience reacted and responded to the shock of COVID-19 pandemic in their farming activities. With this background, the present study has been undertaken to comparatively assess the impacts of COVID-19 on the small scale farming in freshwater and coastal brackish water sectors in India.

1.1 Objectives

The objectives of the study were to comparatively evaluate the impacts on different aspects of farming, instantaneous financial impacts and mitigation strategies adopted by the farmers of their own. Therefore, comparisons were made between COVID-19 study period of the year 2020 and corresponding pre-COVID period of the year 2019 in two distinctly different farming systems under freshwater carp culture and coastal brackish water shrimp culture.

2 Materials and methods

The present study has been conducted from April to August 2020 simultaneously in the purposively selected Hooghly district (22.53°N and 88.23° E) of West Bengal (Site-FW) to assess COVID-19 impacts on small scale freshwater aquaculture, and,

Cuddalore district (11.61° N and 79.65° E) of Tamil Nadu (Site-BW) (Appendix I and II) to assess the impacts on coastal shrimp farming. Hooghly district is bestowed with vast freshwater inland fisheries resources and six among the top ten fish producing districts in West Bengal, whereas, Cuddalore district was selected because of preponderance of small scale coastal shrimp farmers in that area. From both the sites (administrative districts) eight villages each were selected by simple random sampling technique without replacement. Thus, the total number of villages for the present study was 16. From each village, 15 shrimp farmers were randomly selected as respondents thereby comprising 120 respondents each for freshwater and brackish water sectors ($N=240$) which corresponded around 10% of the total small scale aqua farmers in the district. Primary data were collected from each of the respondents through direct interview on-spot following the pre-tested structured questionnaire schedule (Suppl. files). Secondary additional information was also collected from the respective block fishery offices for validation of the data. The data were analysed in terms of percentage and frequency against each variable. Statistical relationship in between two variables was fitted for prediction of degree of relationship between them with R^2 values. Garret's Rank analysis was employed to identify the most perceived extent of problems, mitigation measures and strategies for future incidence of such crises.

3 Results

3.1 Livelihood of the farmers

The study revealed that the major livelihood of 45% of the freshwater fish farmers (Site-FW) depend solely on aquaculture principally composed of composite fish farming of Indian major carps (*Labeo rohita*, *Catla catla* and *Cirrhinus mrigala*) along with exotic carps (*Ctenopharyngodon idella*, *Hypophthalmichthys molitrix* and *Cyprinus carpio*). Along with aquaculture, 25% of farmers have agriculture activity options and the rest 15% depend upon aquaculture and allied fish culture activities like vending fish, artificial fishing, animal husbandry and handicrafts (Fig. 1A).

In contrast, 55.00% depends on aquaculture as primary source of livelihood in the coastal brackish water sector (Site-BW). Following aquaculture, agriculture constitutes 40.00% of total farmer's occupation. Animal husbandry has the least percentage of 5.00% as major source of livelihood (Fig. 1B).

In Site-FW, 90% of the farmers belonged to small to medium-size farms (within 2 ha) of which around 55% of farmers practice fish farming within a pond area of 1 ha only (Fig. 2A). In Site BW also, small farms were prevalent in the Cuddalore district as (66.67%) of the surveyed farmers used to practice shrimp farming in <0.5 ha. The remaining farmers have listed medium-sized farms (21.7%) and large-sized farms (11.67%) (Fig. 2B).

3.2 Impact of COVID-19 on farming practices

3.2.1 Farm activity

During the pandemic period in Site-FW, farm activity indicated that only 8% and 32.5% of farmers were able to practice pre stocking management in March and April respectively, as there was labourer crisis, transportation

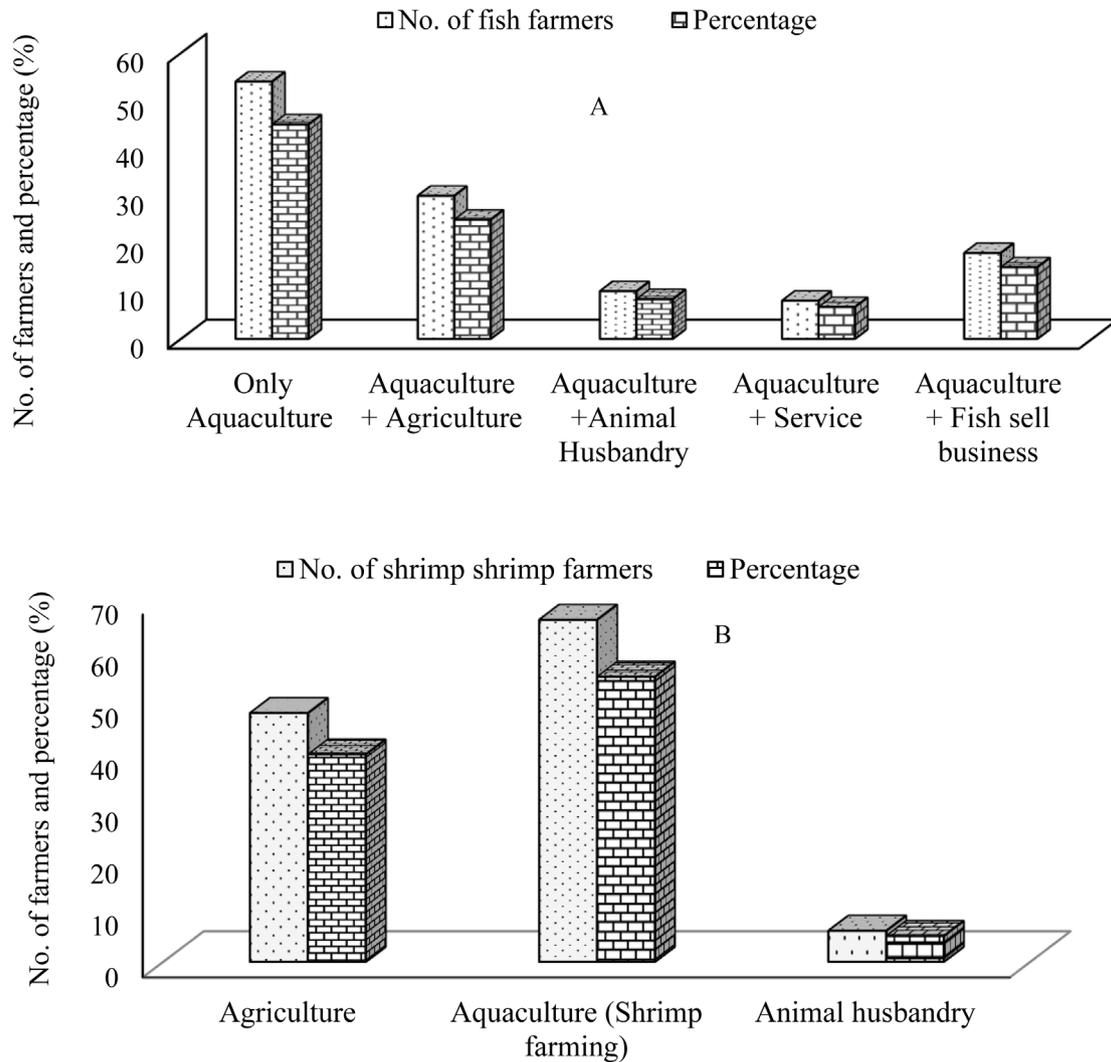


Fig. 1. Sources of livelihood of the farmers (A – Site-FW; B– Site-BW).

problem and strict restrictions imposed related with COVID-19 guidelines by the authority. 72.5% farmers started delayed pre stocking management during mid-May whereas, such activities were completed by March end during the pre-COVID-19 period of the previous year. Only 13.33% of farmers were able to stock fish seed by April–May during the COVID-19 pandemic against 47.5% farmers completed stocking their farm ponds during the corresponding period of the previous year (pre-COVID) (Fig. 3).

In Site-BW, the principal summer cropping had been impacted immensely as majority (58.3%) of the farmers during the onset of the pandemic had to harvest earlier by March-April due to the panic effect in contrast to the corresponding period of the pre-pandemic previous year when 66.8% of the farmers have completed stocking and were engaged in post-stocking grow-out management. They faced constraints like a continuous drop in farm gate price (46.7%), problems in procuring of inputs (55.8%), and transport (79.17%) during March-April. However, the situation started improving from June onwards as the farmers greatly increased their pre-stocking management activities (66.7%) and stocking practice (62.5%)

in June–July due to the increased demand for shrimp in the global market (Fig. 4).

3.2.2 Constraints faced

Because of the country-wide lockdown that started during the end of March, all private and public sector transport services came to a complete halt. As a result, the transportation of fish to the market as a major problem was faced by many farmers. 35% of farmers faced such problem during March. However, most (73%) farmers faced transport problems during April, followed by 67.50%, 47.50% and 27.50% of farmers in May, June and July, respectively in Site-FW. Because of restrictions on public gathering, lockdown and transport crisis, 13.33%, 64.17%, 65.83%, 56.67% and 25.84% farmers faced problem of labourer crisis during March, April, May, June and July respectively. Shortage of transport facilities and marketing problems was the main causes of non-availability of seeds during the pandemic. As March and April months were ideal for stocking of Indian major carps spawn and fry, 81% of the farmers could not collect seeds till April. Although Social

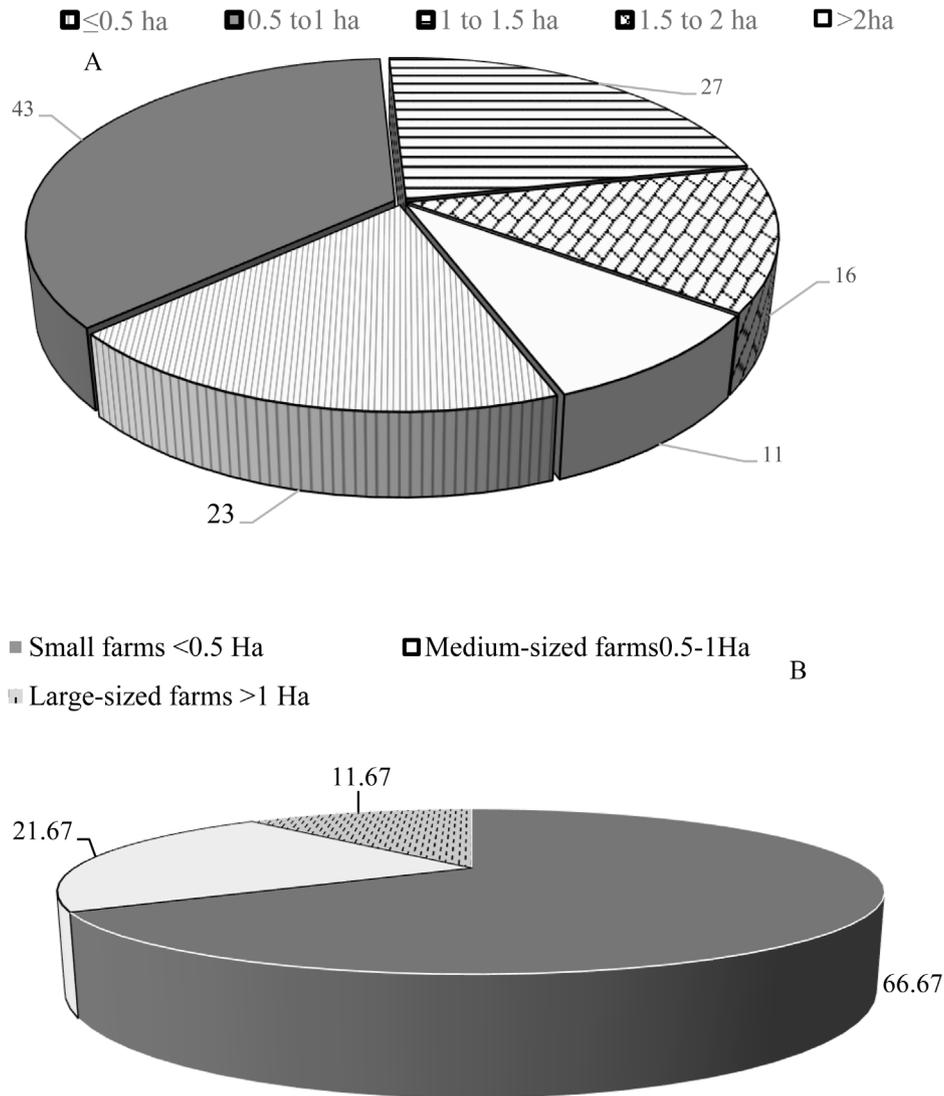


Fig. 2. Farm size of the farmers studied (A – Site-FW; B – Site-BW).

distancing was one of the main issues during lockdown, farmers were not been able to maintain lockdown in true sense. 15.83% of the farmers did not maintain social distancing during farm operation and marketing. The percentage increased with time ranging from 42.5% to 80% during April through July. 35% and 31.67% of farmers faced problems associated with police action or local administrative restriction at the beginning of the pandemic in March and April respectively. With time this issue caused less trouble to farmers as the restrictions on agriculture, fishery product transportation slowly eased. Regarding input availability, 28% of farmers faced acute crisis in procuring inputs like feed, fertilizer, lime, medicine, aerators, etc. in April. Such problem was faced by 19.17%, 23.34%, 20.83% and 21.67% of the farmers in March, May, June, July respectively. With regards to marketing constraints, most of the farmers (51.67%) faced it in April during the first phase of lockdown. Though 20.84% of farmers got trouble in marketing of fish during March, 35.84% and

17.5% of farmers got trouble in May and June respectively. In July, 10.84% farmers faced police restriction (Fig. 3)

In Site-BW, 79.17% of the farmers faced transport during March as a constraint followed by 71.70%, 59.20%, 55.80%, 55.80%, and 15.00% farmers reported social distancing, lack of labourer, decreased farm gate price, difficulties in procurement and purchasing of inputs, disease outbreak respectively (Fig. 4). Most of the farmers (78.25%) have not faced the constraints like increased feed price, increased seed price and poor seed quality during the March–May. However, during June–July, decreased farm gate price, increased feed and seed price was emerged as major constraints by 87.50%, 80.83% and 60% farmers. Moreover, poor-quality seeds (40.8%) have also been reported due to old brood stock used in a shrimp hatchery. 30% of the farmers have faced credit issues with the input dealers during the study period. Constraints like transportation, lack of labourers, social distancing, and police action gradually eased out from mid-June–July. 47.5% and 42.5% of farmers were unable to

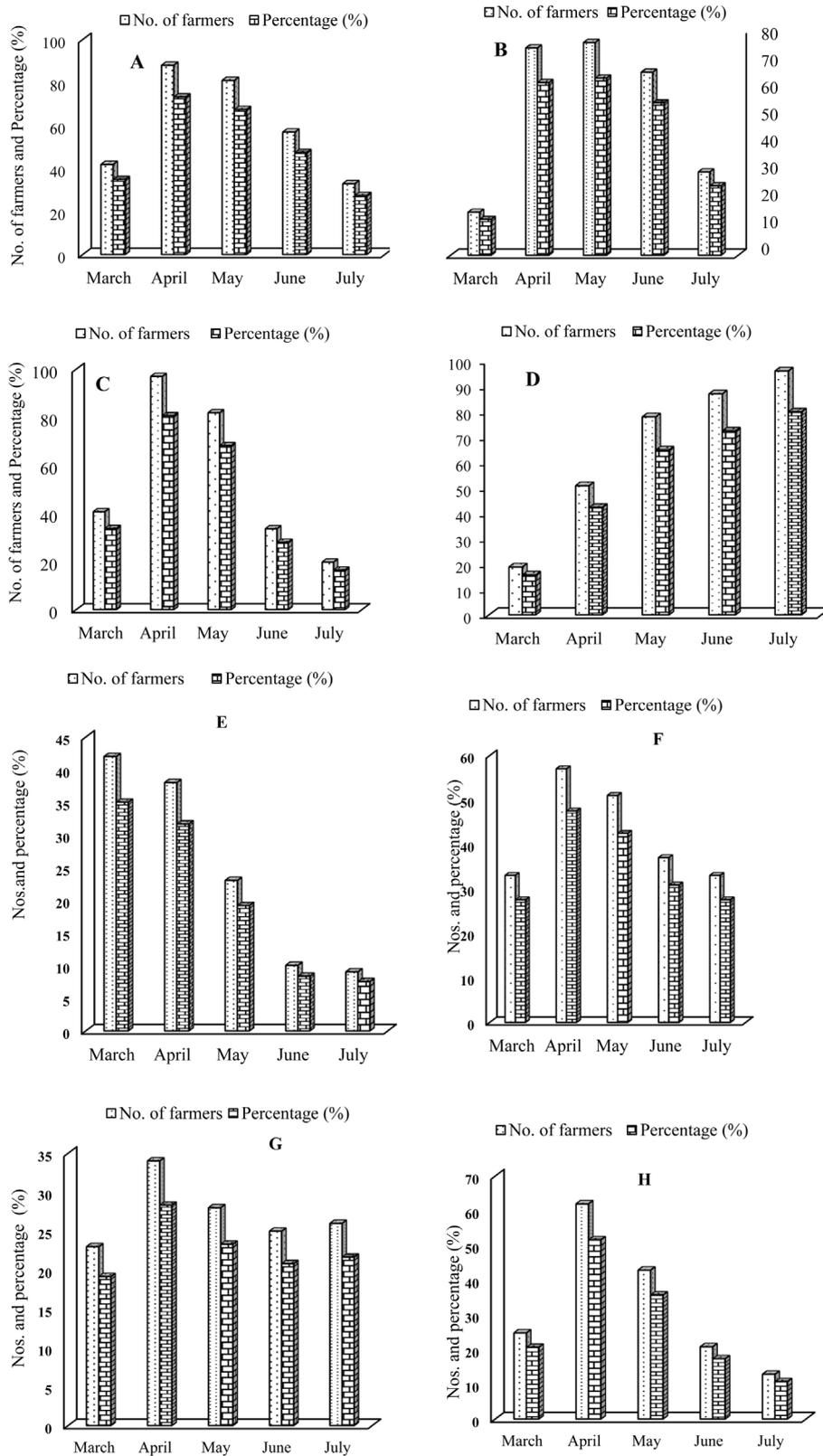


Fig. 3. Constraints faced by the farmers during COVID-19 in Site-FW (A – Transport; B – Crisis of labour; C – Seed availability; D – Social distancing; E – Police action in enforcing lock-down; F – Harvesting; G – Input availability and, H – Marketing) in different months.

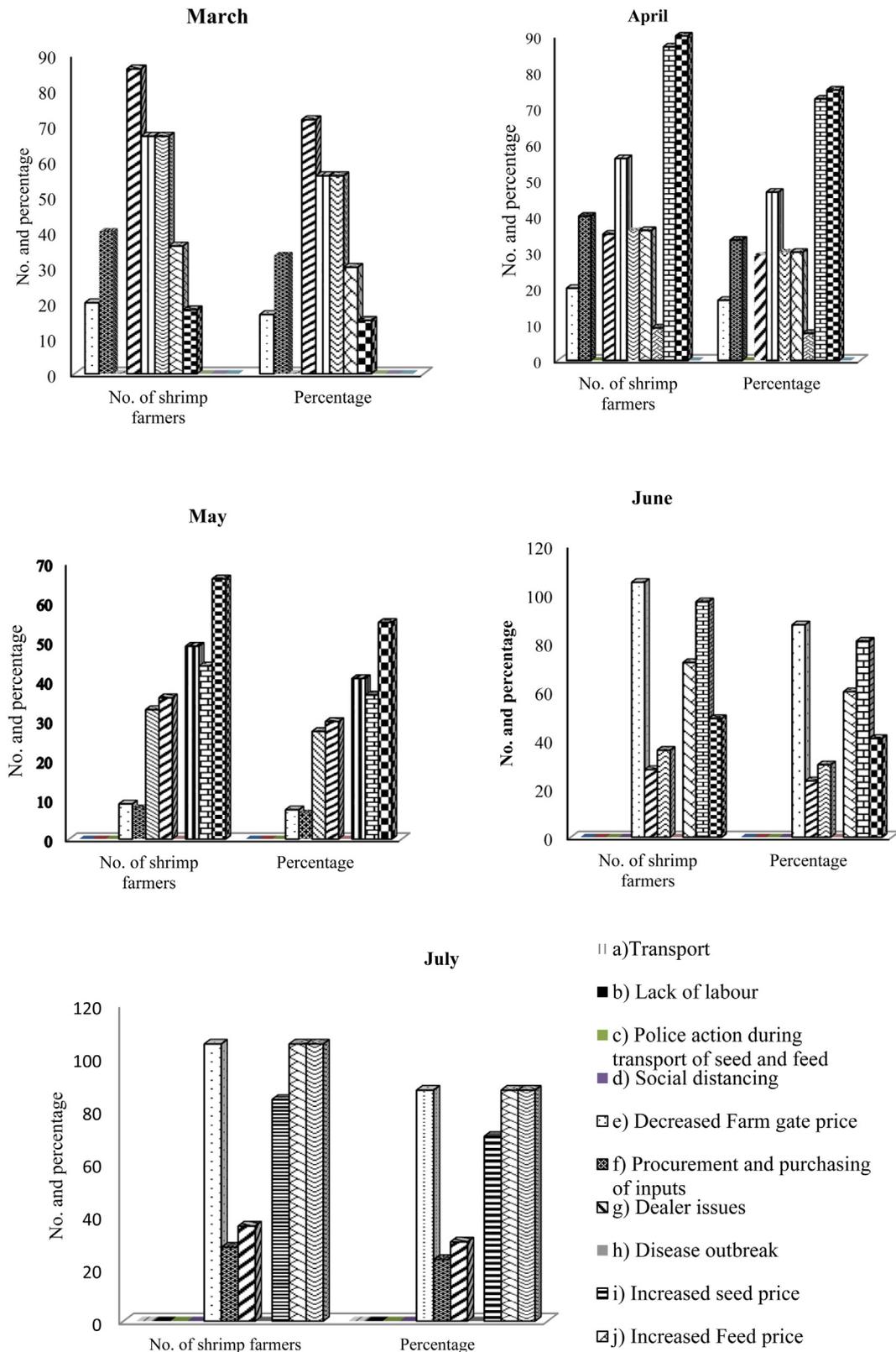


Fig. 4. Constraints faced by the farmers during COVID-19 in Site-BW in different months (Legends are identical in each month).

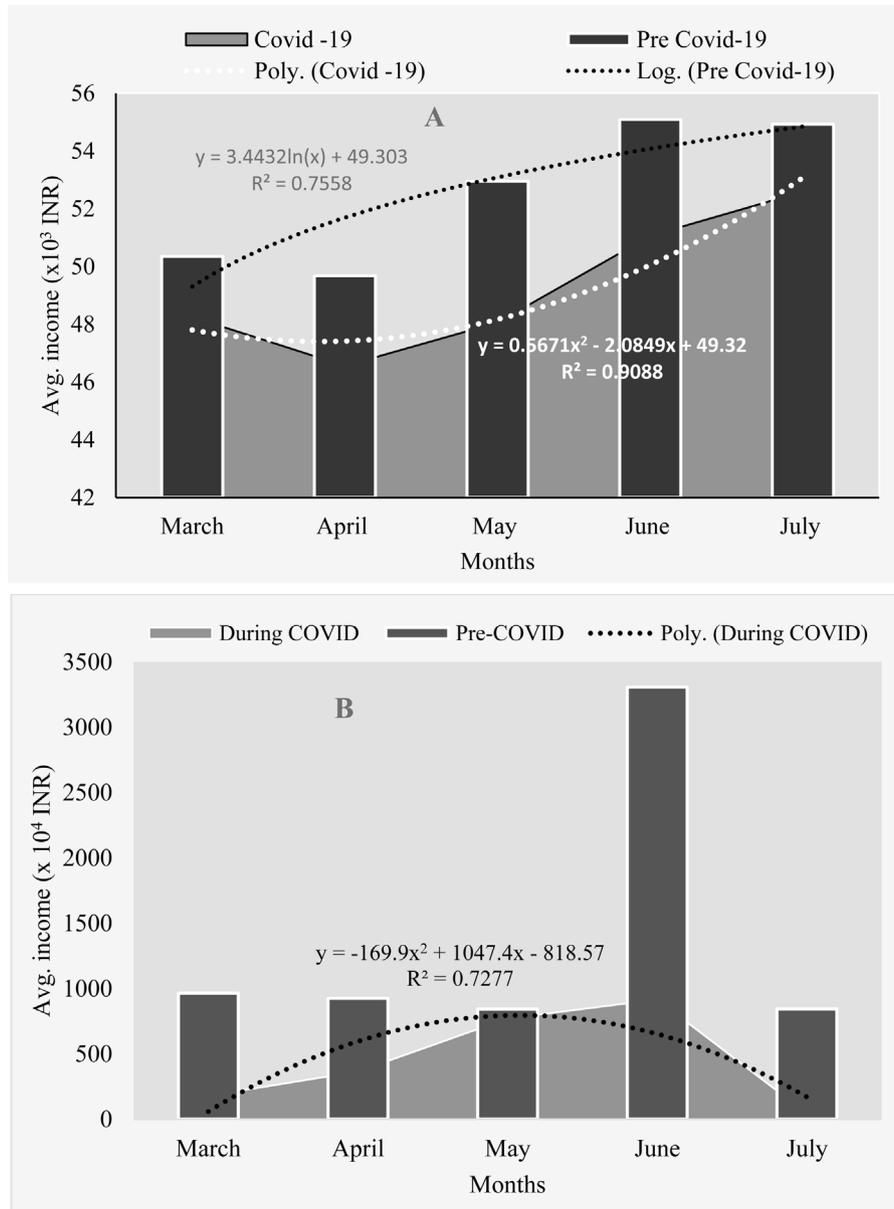


Fig. 5. Monthly income during pre-COVID-19 and COVID-19 period of the farmers in Site-FW (A) and Site- BW (B).

harvest or postponed their harvest due to lack of labourer, marking and shortage of transport during April and May respectively. 27.5% farmers faced same issue both in March and July (Fig. 4).

3.3 Impact of COVID-19 on farmers' income

In Site-FW, average income from aquaculture sector ranged from Rs. 35000 to 72600 and Rs. 32400 to 70000 during the pre-COVID-19 and COVID-19 period respectively. Income from aquaculture reduced substantially during the five months study period within the ongoing COVID-19 pandemic when compared to the corresponding period of the previous period (pre COVID-19). The extent of less income incurred by the farmers ranged from 1.2–38%, 1.19–32%, 5.2–27.27%, 5.0–37.71% and 5.71–32.14% during March to July

respectively during the pandemic. In contrast, in (Site-BW), the extent of income reduction from aquaculture was intense as during the COVID-19 pandemic, it was reduced by 63.6 to 67% and the most drastic reduction was encountered during the month of June compared to the corresponding period of last year (Pre COVID-19).

Though, during the corresponding study period of pre-COVID-19, average income of the farmers increased logarithmically ($y = 3.4432\ln(x) + 49.303$; $R^2 = 0.7558$), the trend of recovery following a fall in income during the COVID-19 period was demonstrated in a polynomial pathway ($y = 0.5671x^2 - 2.0849x + 49.32$; $R^2 = 0.9088$) in Site-FW (Fig. 5A). There was no definite fit in income during the pre-COVID-19 period in Site-BW, but income distribution was polynomial ($y = -169.9x^2 + 1047.4x - 818.57$; $R^2 = 0.7277$) during the COVID-19 period (Fig. 5B).

Table 1. Mitigation strategies adopted by the farmers during COVID-19.

Mitigation strategies	Site-FW	Site-BW
Application of mohua oil cake for eradication of unwanted fish during pre-stocking management.	Omitted by 80%	Not practised usually
Stocking with advanced fingerlings instead of fingerlings because of delayed stocking period.	85.55%	Stocking density was reduced by 85%
Application of organic manure during pre-stocking pond preparation	Omitted by 88% farmers	Nil
Application of inorganic fertilizer usually not done	Done by 78.33% farmers	Done by 42.50% farmers
Usual eradication of weeds before stocking	80% farmers after stocking.	Nil
Disease management	None	17.5%
Postponed harvesting	78% farmers	28.30%
Early Harvesting	<5% farmers	57.50% farmers
Partial harvesting	63.33% farmers	14.20% farmers
Monthly harvesting	22.5% farmers during final phase of lock down	Nil
Feed	Locally available feed ingredients by 57% farmers	76.7% farmers adopted mineral mixture application to boost natural feed
Involving women workforce of the family during labourer crisis.	37.5% farmers	Nil
Farmers turned door to door vendors of live fish/shrimp	56.75%	15.25%

Table 2. Farmers' Perception in mitigating the crisis.

Perception	Freshwater farmers (%)	Brackish water farmers (%)
It will not impact my aquafarming much	57.5	66
It will be short lived	38	42.50
It will not affect me economically in future	33	10.33
Everything will normalized within 2–3 months	68	21.00
No need of panic, will manage of his own means	59	7.5
Sure to overcome economic crisis	93.33	85.05
Need credit from Govt. Agency	47.50	50
Need training from block level /district level fishery office	40	25.8
Need proper training to handle COVID-19 like situation	17.50	–
Relaxations in traffic regulation for fish transportation	35.55	48.65
Less political activity	8	22.05
More NGO's involvement	12	25.65

3.4 Impact of COVID-19 on livelihood of the farmers

Regarding source of livelihood in Site-FW, during pre-COVID-19, 50% of farmers totally depended solely on aquaculture whereas, 20% of farmers were dependent on agriculture and, 6.66% used to practice fish vending, handicrafts and animal husbandry (5.83%) as secondary sources of livelihood along with aquaculture. However, during COVID-19 pandemic, there was increased dependence

on agriculture and Govt. ration as a secondary source of livelihood along with aquaculture. Most of farmers (63.33%) collected Govt. ration as a secondary source of livelihood followed by agriculture (28.33%), animal husbandry (9.16%), and, 19.16% farmers reported others occupation like fish selling business, handicrafts, artitional fishing as secondary sources of livelihood.

In contrast, as the coastal shrimp farmers were left with limited option of secondary livelihood except marine fishing (33.08%)

and animal husbandry (27.25%), during the COVID-19 pandemic, 80.55% farmers depended on Govt. supplied free ration and the rest on fishing as their principal mode of livelihood.

3.5 Mitigation strategies adopted by the farmers during COVID-19

3.5.1 Freshwater sector

During the COVID-19 period of study, in Site-FW, application of mohua (*Bassia latifolia*) oil cake (MOC) as a measure for eradication of predatory or unwanted fishes before stocking was omitted by 80% of the farmers to avoid further delaying in stocking fish fry and/or fingerlings. Rather, they (85.55%) have stocked their ponds with advanced size fingerlings to compete with the unwanted fish in the culture system.

Application of cow manure as usual practice was not followed by 88% of the farmers during pond preparation. Instead, application of inorganic fertilizer was done by 78.33% of farmer to get instant fertilization effect. Urea and phosphate fertilizer were applied by 63% and 68% of the farmers, respectively. Most of (80%) farmers eradicated weeds their pond only after stocking which was contrary to the usual pre-stocking management practice.

To mitigate transportation and marketing problems, 78% farmers postponed harvesting during the first phase of lockdown (March–April), and they continued regular feeding and management of water quality of their old stock. As the availability of commercial feed was disrupted, 57% of farmers practiced feeding with locally available rice bran, ground nut oil cake or mustard oil cake and flour mixture as supplementary feed (Tab. 1).

Majority of the farmers (63.33%) adopted partial harvesting as per the localized market demand during March–April. After the initial set back when consumer demand gradually increased, 22.5% farmers monthly harvesting (Tab. 1).

3.5.2 Coastal shrimp farming sector

Ten mitigation strategies have been reported during the study in Site-BW. The stocking density was reduced by 85% of the farmers to mitigate disruption of marketing channels and decreased global demand. 76.7% farmers adopted mineral mixture application to condition their pond environment, and, 72.5% adopted late stocking to ease out the crisis. Early harvesting (57.5%), liming (43.3%), fertilization (42.5%), pond preparation (37.5%), late harvesting (28.3%), disease management (17.5%) during the study period were also emerged as other mitigation strategies in the coastal brackish water shrimp farming. The least percentage of farmers (14.2%) has adopted partial harvesting (Tab. 1).

3.6 Farmers' perception in mitigating the crisis

In Site-FW, 57.5% of farmers perceived that the pandemic related crisis did not impact too much in their small-scale aquafarming. Around 33% farmers opined that they will not be affected economically in future crisis. 38% farmers thought that the pandemic situation will last only for a short period of few months, though majority (62%) expressed concerns that the pandemic crisis will continue for long. 59% farmers

suggested no need of panic as they could be able to manage the crisis of their own means. Majority of the farmers (93.33%) mention that aquafarming with agriculture, business, animal husbandry helped them to overcome economic crisis (Tab. 2).

In Site-BW, majority (66%) of the farmers opined that such situation will not affect them economically substantially, 42.5% perceived that it will be short-lived, 20.8% expressed that they were affected both economically and mentally, and only 10.8% opined that they were not affected significantly. The lowest percentage (7.5%) opined that there was no need of panic, they would manage the crisis by their own means (Tab. 2). Farmers' perception widely differed in Site-FW and Site-BW as Garret's Rank analysis revealed that in the former, integration with other production sectors ranked first as mitigation perception, whereas, in the later the highest rank was with the perception that everything will be normalized within 2–3 months (Tab. 2).

3.7 Farmers' need in mitigating the crisis

Considering both Site-FW and Site-BW, 47.5–50% farmers perceived that they would have been benefitted if they were provided financial support or small credit from the Govt. agencies. 40% of Site-FW wanted more involvement of the block and district level government fishery office in terms of training, providing input like seeds, fertilizer, lime, net, and other basic inputs, whereas, such need was perceived by lesser percentage of farmers in Site-BW (25.8%). 17.5% farmers in Site-FW thought, they should get proper training for handling COVID-19 like situation as the pandemic was new to them and such crisis related with farm activity was unknown to them. However, none of the farmers from Site-BW opined like that way. 35.55% and 48.65% of farmers from Site-FW and Site-BW respectively, expressed strongly against strict transportation rules and regulations as they wanted flexibility in transportation of essential perishable products like fish, meat, milk, vegetables. Around 8% and 12% suggested less political activity and more NGO's activity in the field of fishery in Site-FW and Site-BW, respectively. Garret's Rank analysis revealed that in both the sectors, the farmers most important need was credit from the Govt. source followed by ease in transportation in mitigating COVID-19 like crisis in future.

3.8 Preparedness plan for future

With regards to preparedness for future crisis, 61.70% farmers opined postponed harvesting and marketing prior to the severity of the crisis in Site-BW followed by 53.3%, 35.8%, 31.7% of farmers who suggested increased saving by reducing expenditure where ever possible, overstocking of inputs like lime, fertilizer, feed, etc. and d) postponing stocking of seed, respectively. As the farm gate price fluctuated widely during the study period of the ongoing pandemic, 61.70% farmers suggested that government should fix the farm gate price as they were dependent on export markets for selling their produce. Moreover, as the COVID-19 pandemic acted as an impetus to increase the domestic market demand, 35% farmers suggested domestic market influences on cultured shrimp to be increased further by other means. 52.5% of the farmers expressed need of farmers' association for fulfilling their demands towards mitigation of future crisis. According to 50%

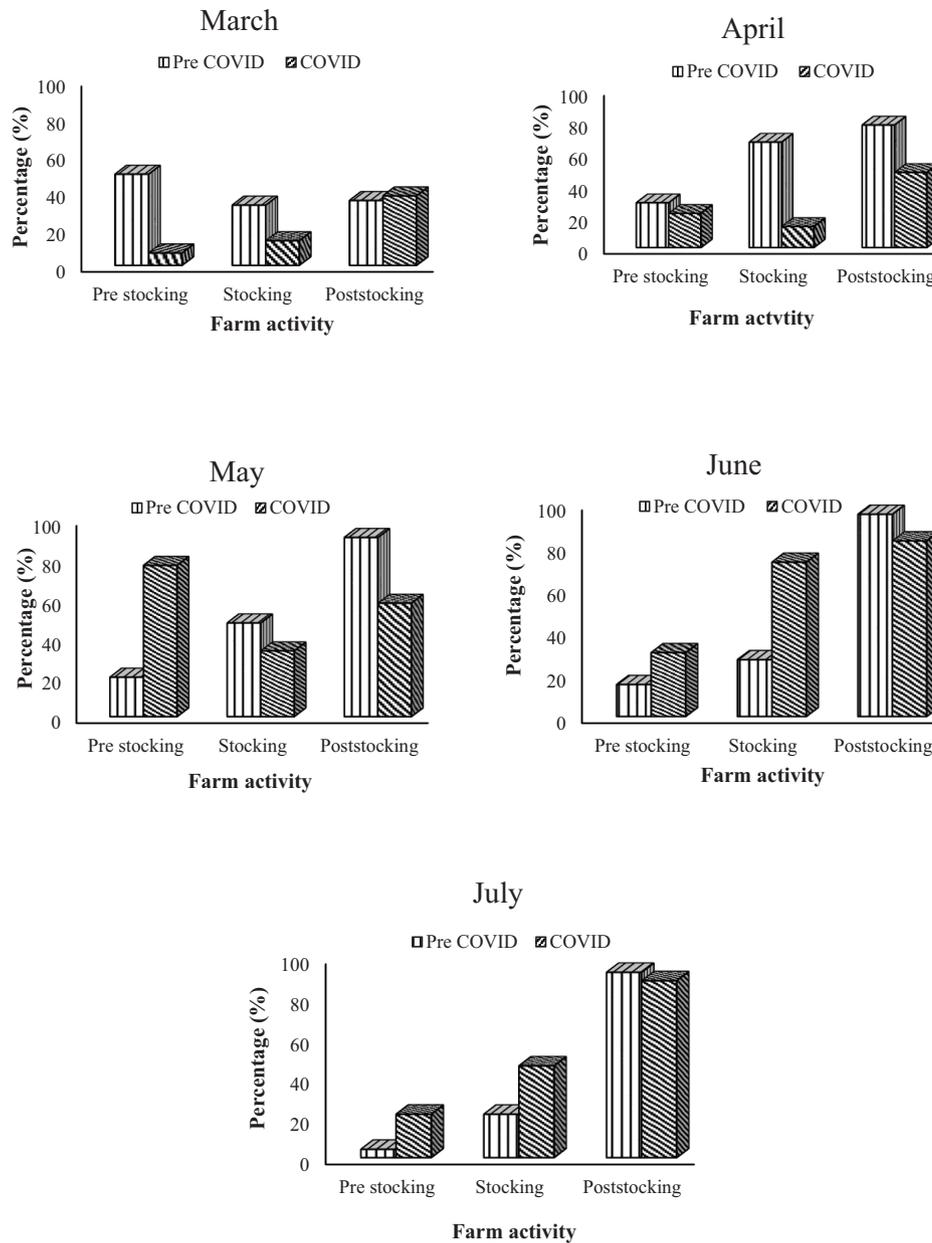


Fig. 6. Differential performance of farm activities during the Pre-COVID and COVID period in FW site.

of the shrimp farmers, government support was needed in terms of finance and security to help the shrimp farming community. 45.8% of the farmers have suggested that the government should fix the price of shrimp seed. Proper training to handle future pandemic like situation was recommended by 25.8% farmers.

Garret's Rank analysis clearly indicated that in Site-FW, farmers' perception of increased savings in curtailing expenditure where ever possible would be the most important strategy in mitigating the similar crisis in future. This is in contrast to Site-BW, where the shrimp farmers perceived that early sensing the severity of the crisis and preponement of harvesting followed by marketing would be the most effective strategy.

4 Discussion

Farm activity during COVID-19 pandemic in Site-FW indicated distinctly altered farm activity during the COVID-19 pandemic in comparison of the corresponding period of the previous year (pre COVID-19). It was clearly described that because of lockdown and it's fall-outs, trends in different categories of farm activity viz. pre-stocking, stocking and post stocking operations reversed during the pandemic during March to May (Fig. 6). The trend in distribution percentage of different categories of operation though normalized gradually, operational intensity of pre-stocking and stocking management surpassed to that of pre-COVID-19 period of

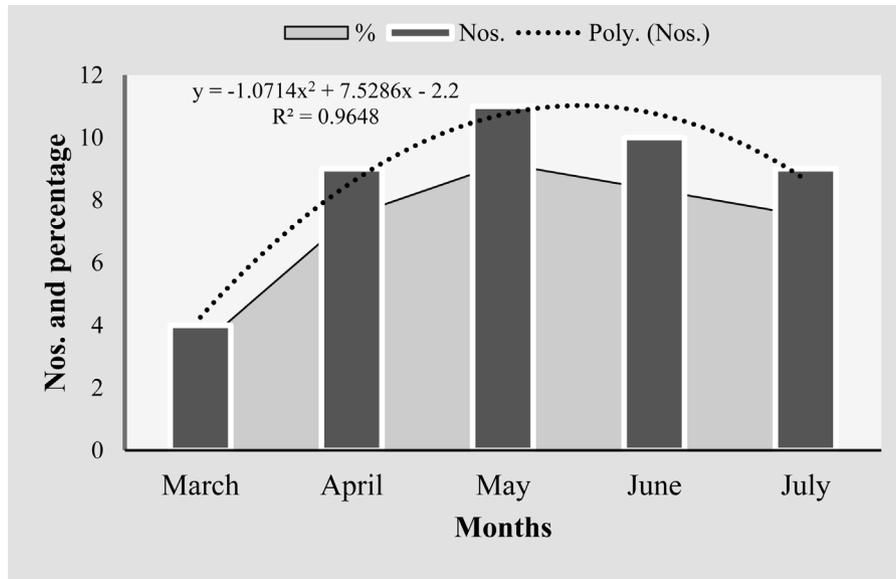


Fig. 7. Temporal changes of Womens' participation in the freshwater farming activities during the COVID pandemic.

the corresponding year. This was evident from the fact that 67.67% farmers stocked their ponds during April in pre-pandemic year that corresponded with only 13.33% during the same period in pandemic. Therefore, stocking of fish seed in general, was delayed by two months as most of the stocking was done during June-July during the pandemic. Women's participation in the farming practices though recorded nil during the pre COVID-19 period, because of unavailability of labourer and or to reduce expenditure towards hiring labour during the pandemic period, it increased ($y = -1.0714x^2 + 7.5286x - 2.2$; $R^2 = 0.9648$) with time attaining peak during May (Fig. 7). It was noteworthy as women's participation was not usual in the farm operation in the studied area primarily because of socio-cultural taboos and gender inequality. However, such participation of women workforce from the family itself was not recorded in Site-BW. Women's involvement in small-scale aquaculture production in Bangladesh and Cambodia helps in increasing productivity (Barman and Little, 2006; Jahan *et al.*, 2010; Monfort, 2015; Shirajee *et al.*, 2010) and fish consumption within the household (Heck *et al.*, 2007; Jahan *et al.*, 2010; Kawarazuka and Béné, 2010).

The results of the present study clearly indicated the changes of livelihood patterns during the COVID-19 period because of forced shifting and increased dependence on allied farming and husbandry practices; even distinctly related handicrafts sectors. Moreover, because of complete halt of transportation system, social distancing, police action, non-availability of farming inputs includes seeds and market chain disruption negatively impacted the farmers surveyed in the present study. The major problems emerged out in the farming sector was delay in stocking because of non-availability of seed and harvesting because of paucity of labourer along with social distancing factors. However, it was noteworthy from the results that during farm activities and marketing, social distancing could not be maintained in true sense by a large

section of the studied farmers and the trend increased as the time progressed. Therefore, such advisories of social distancing and related issues should have been more realistic and specific sector wise considering the ground realities in operational level rather generalized for the masses.

Among the sources, aquaculture suffered most as evident from the study where magnitude of loss was highest in comparison to agriculture and other secondary sources of livelihood. This was because of the timing of the imposition of COVID-19 related lockdown and other restrictive measures when the farmers usually harvest their produce in normal conditions. Moreover, the initial period of the study corresponds with the timing of pre-stocking preparations of the ponds followed by fresh stocking of the ponds for the next crop when lockdown and social distancing norms were imposed. As a result, the farmers could not be able to harvest and market their produce due to shortage of labour, breakdown of transport system and marketing channels. However, during the latter part of the study, the situation somewhat eased with formation of localized markets and marketing channels governed by the small scale freshwater fish farmers themselves as door to door vendors with fresh catches. Such new dimensions in marketing during the pandemic not only helped the suffering farmers in overcoming the crisis substantially but the movement restricted consumers also got benefitted with door step availability of fresh fish during the crisis. OECD (2020) also observed that such development is an interesting trend that could have lasting impacts on fish supply chains in terms of improved traceability, lower hygiene management costs, and the potential to encourage consumption of sustainably sourced local and seasonal fish. Such approaches could also result in higher benefits for fishers and the overall resilience of the sector if current growth trends persist during the post-pandemic period. Though the farmers in Site-FW had heterogenous income sources as their secondary sources of livelihood; Govt. assistance in the form of free ration through

Public Distribution System helped the farmers to manage the crisis in a big way. In general, the OECD recommends government support policies in response to the COVID-19 pandemic be time-limited, targeted, cash-based, and consistent with longer-term sustainability objectives (OECD, 2020). As none of the farmers had prior experience to cope with and mitigate such crisis like COVID-19 pandemic, the farmers had to act of their own as per the situational demand. As mitigation strategy, most of the farmers continued with their old stock, feeding with locally available supplementary feed stuff like oil cake, rice bran, wheat floor etc. as they were not able to harvest their produce. As and when the situation became slowly eased out considerably and the local market and localized short marketing channels developed; instead of complete harvesting, the farmers adopted partial and irregular harvesting strategy as per the local market demand.

Comparatively, the negative impacts of COVID-19 upon coastal shrimp farming (Site-BW) emerged as more pronounced than fresh water carp farming in the present study. This is because, the principal summer cropping schedule that contributes 60% of the Indian shrimp production, has corresponded with the lockdown related fallouts of disruption of input supply chain, break-down of marketing channels and sudden crash in international market demand. Kumaran *et al.*, (2020) reported that shrimp farming has two major seasons in India viz., summer crop (March–April to June July) and the winter crop (July–August to November–December). The impact was higher also because there was least integration among other sectors as secondary sources of livelihood like agriculture and handicrafts as emerged in the freshwater sector. As shrimp farming in India, primarily has to depend on market externalities of the export market leaving behind limited local domestic market support, during the lockdown period as the global marketing channels were completely disrupted, it had a direct bearing upon the whole farming activity. This was in contrast with the freshwater sector in which there was steady and strong local market support for the produce. The farmers themselves turned into direct selling door to door vendor of live fish to the consumer's house hold during the restriction period that emerged an effective crisis management strategy in the freshwater sector.

Shrimp farming sector in the study area has to depend upon the availability of inputs on credit from the input dealers. This has emerged as another major hinderance in shrimp farming unlike freshwater carp farming that largely depend upon locally available low-cost agricultural and animal husbandry by-products/wastes viz. bran, oil cakes, manure etc. It was evident from the results that dealer's credit issue was raise by most of the farmers in Site-BW as one of the major constraints and the farmers also expressed their need for Govt. subsidies/credit and minimum support price as guaranteed farm gate price. Basu (1997) reported that non-institutional sources cannot fulfill farmers' demand for credit due to associated problems like as need for collateral and production guarantees. Therefore, delayed harvesting of carps as mitigation strategy in Site-FW with continued rearing of the old stock by the farmers with low-cost inputs during marketing problems was judicious.

However, with costly commercial feed and other inputs, rearing old stock for longer thus delaying harvesting was impracticable in Site-BW. As a result, the farmers had to go for early harvest and make distress sell of their shrimps in the local

market. Kumaran *et al.* (2020) also mentioned that anticipating drop in prices and worsening market conditions, around 50% of the farmers who had a standing crop with small and medium-sized shrimps decided for harvest and made a "distress sale". In both the sectors under the present study, Govt. assistance in the form of free ration through Public Distribution System helped the farmers to mitigate the crises in a big way. In general, the OECD recommends government support policies in response to the COVID-19 pandemic be time-limited, targeted, cash-based, and consistent with longer-term sustainability objectives (OECD, 2020).

5 Conclusion

The present study is novel as this is the first of it's kind that was conducted with immense hinderance during the peak of the pandemic in diversely different farming systems situated apart at about 2000 km distance. It is clearly indicated that the sudden impact of COVID-19 in general, was conspicuous in both the freshwater small scale carp farming and coastal brackish water shrimp farming sectors. Because of local market support, low cost locally available inputs, comparatively with greater scope of integration, wide option of alternative secondary livelihood and mobilization of women work force in the freshwater sector, the instantaneous impact though was intense, but mitigation was easier in comparison to the costly input and external market dependent brackish water shrimp farming sector where, scope of integration of other production sectors with aquaculture was limited, and, mobilization of the women work force during the time of labourer crisis was nil. The principal attributes in mitigating the COVID-19 in the freshwater sector were integration with the local market and mobilization of untapped resources in the form of women's labor. Contrary to this brackish water shrimp farming sector has exhibited much less resilience to such crises, where cross-sectorial integration and income diversification opportunities were limited and marketing is bound with externalities.

Authors contributions

D. Hait: Performed in data collection, analyses of data in the FW site. M. Vignesh: Performed in data collection and analyses of data in the BW site. S. K. Das: Conceptualization, critical analyses of the results and finalization of the write-ups.

Conflict of interests

There is no conflict of interests in any means among the authors or anybody related with this research.

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Data availability statement

All data will be shared upon request from anybody solely to be used for academic, non-commercial purposes.

Supplementary Material

The Supplementary Material is available at <https://www.alr-journal.org/10.1051/alr/2022020/olm>.

Appendix I. Socio-economic status of the small-scale fish farmers and impact of COVID-19 on farming activities in Hooghly district, West Bengal.

Appendix II. Impact of COVID 19 on small scale coastal aquafarming in Cuddalore district, Tamil Nadu, India.

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