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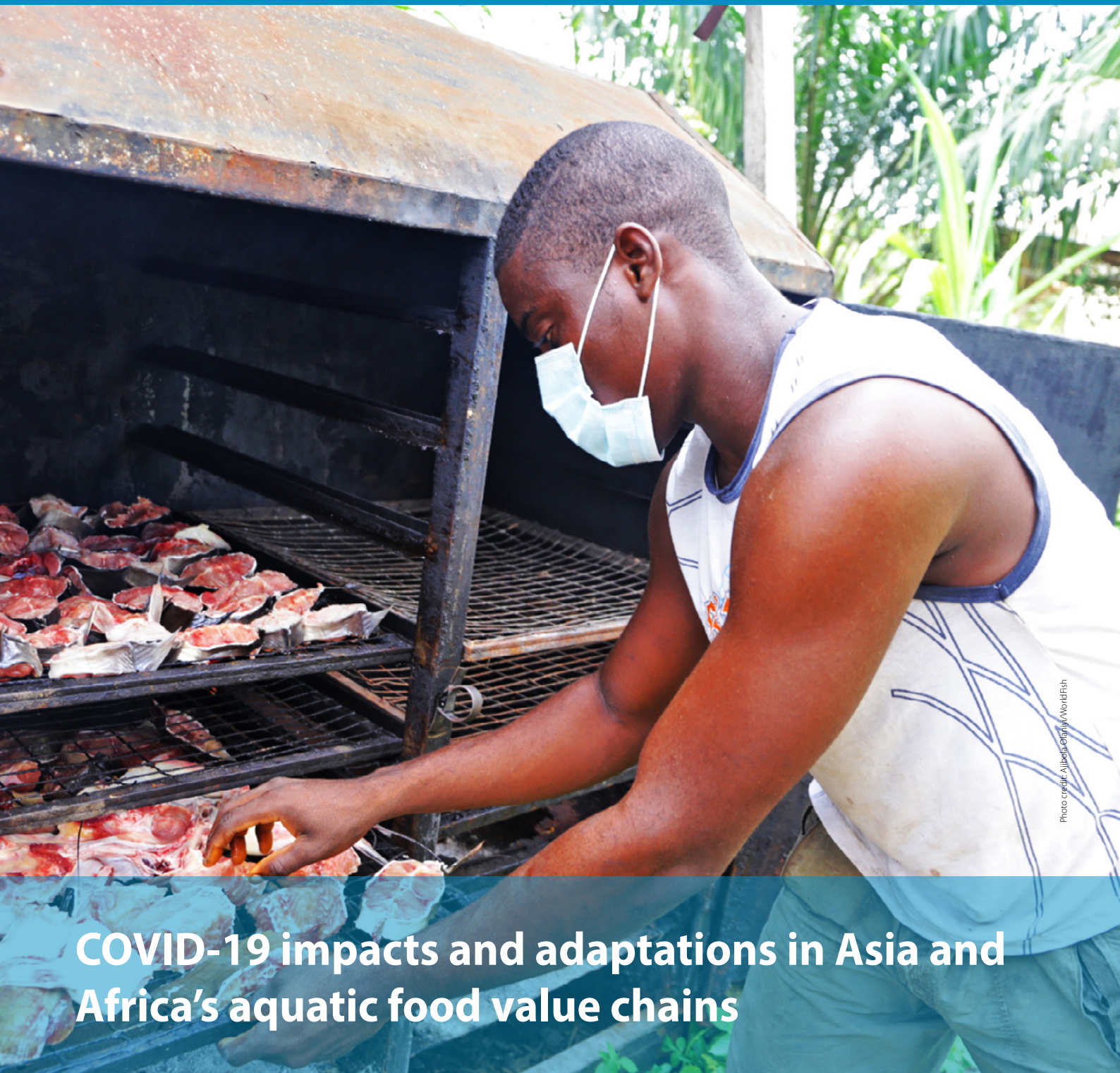


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COVID-19 impacts and adaptations in Asia and Africa's aquatic food value chains

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COVID-19 impacts and adaptations in Asia and Africa's aquatic food value chains

Authors

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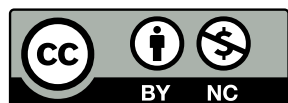
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Executive summary

We tracked the impacts of COVID-19 on aquatic food value chains in Bangladesh, Egypt, India, Myanmar and Nigeria during 2020. We assessed the availability and price of aquatic foods and production inputs using a high frequency panel survey of 767 actors from eight value chain nodes. We also conducted semi-structured phone interviews with 63 respondents in Bangladesh and online interviews with 100 aquatic food value chain actors and key informants from 17 sub-Saharan African countries. This information provides insights into the pathways by which the crisis has affected aquatic food value chain actors, the scale of those impacts and how they have adapted. These findings give rise to policy recommendations aimed at mitigating impacts in the present, assisting recovery and building a more resilient aquatic food system in the future.

Results

The following results stand out:

- **COVID-19 and associated containment measures severely disrupted aquatic food value chains, but effects on supply were relatively short-lived.**
- **Demand for aquatic foods has yet to recover to pre-pandemic levels.** Demand for production inputs and services also remains low, resulting in substantially lower incomes for businesses and workers throughout the value chain compared to 2019.
- **Prices of aquatic foods have trended downward over the course of the pandemic, apart from a brief spike in retail prices during March–May 2020.** This trend reflects depressed consumer demand.
- **Prices of manufactured feeds have risen.** This reflects increased costs of doing business and inflation, though prices of most raw materials for feed have remained relatively stable, in line with international agricultural commodity prices.
- **Aquatic food value chain actors have adapted to challenges in multiple ways.** These include reducing production costs, using alternative inputs, leveraging social capital via informal networks, borrowing, seeking alternative employment and reducing food consumption.
- **Coping strategies allow smaller producers and other actors to persist in the short run.** However, they seem likely to undermine well-being and longer-term resilience.
- **Larger businesses appear to have greater capacity to adapt proactively.** These advantages may deepen as the COVID-19 crisis continues, leading to concentration in some value chain segments.
- **Formal assistance has been limited.** In most of the countries surveyed, few respondents received financial or other support from government and other agencies.
- **COVID-19 has exacerbated pre-existing inequalities.** Asset-poor actors and those in precarious occupations have proven most vulnerable to financial, food and nutrition insecurity and health risks, with highly gendered consequences.

Conclusions

- **The global COVID-19 pandemic has already reversed years of progress on key human development indicators.** The regions most affected are sub-Saharan Africa and South Asia. Public health interventions continue to play an important role in saving lives, but the deepening economic crisis demands a renewed emphasis on protecting livelihoods and human nutritional status.
- **Prior to the COVID-19 pandemic, the potential of aquatic food value chains to drive progress toward development goals made them important areas for investment and intervention.** This potential makes renewed investments in aquatic food value chains and the livelihoods they support even more important in the context of post-COVID-19 recovery efforts.
- **Revitalizing aquatic food value chains can play a critical role in protecting livelihoods and human nutrition.** It will boost both employment and income and will contribute to demand for aquatic foods and other goods and services.

Recommendations

Our first set of recommendations addresses the immediate supply-side impacts of the pandemic. It includes the following points:

- **Keeping value chains functioning smoothly is paramount to avoid supply-side shocks.** Ensure that logistics services, physical marketplaces, and value chains delivering inputs are designated essential and kept open and operating, with social distancing, sanitization and personal protective equipment provision to protect public health.
- **Designate workers in all segments of aquatic food value chains as essential.** Special consideration should be given to mitigating the effects of containment policies on migrant workers, who make up a significant part of the workforce in many aquatic food value chains.
- **Establish regular processes of consultation.** Discussions between government, fisheries professionals and relevant business associations at national and sub-national levels must quickly identify emerging problems in aquatic food value chains and agree on and implement remedies.

Emergency financial support to actors in aquatic food value chains has been limited to date. Where such schemes are implemented, they should consider the following points:

- **When allocating resources, accord value chain actors such as traders, transporters, input suppliers and processors the same priority as producers.**
- **Focus on small and medium enterprises, farms and fishers.** These are more labor-intensive (employing many more people) than large enterprises and account for most of the aquatic food produced and traded in the Global South.
- **Ensure that aid packages are scaled progressively to maximize impact.** For example, when providing financial aid to farms, payments can be made on a sliding scale weighted in favor of smaller farm sizes, rather than allocating a flat fee per unit area.

In most of the countries studied, the reach of formal social safety nets appears to have been limited or patchy. However, if implemented widely, safety nets can play important roles in mitigating the impacts of shocks on the poor and vulnerable. We observe the following:

- **Cash transfers have potential to increase consumption of nutritious aquatic foods and stimulate demand for their production.** Disbursement can be timed to coincide with implementation of lockdowns, or other periods of acute stress, and be targeted to poor or vulnerable groups, including women of reproductive age.
- **Aquatic foods such as dried fish can be included in food aid packages.** They are nutritious, culturally appropriate, convenient, low-cost foods, and an alternative to nutritional supplements that can also stimulate demand for production.

Recommendations for the long term are aimed at revitalizing aquatic food value chains to protect livelihoods and human nutrition, boost employment and income, contribute to post-pandemic recovery and promote resilience to future shocks. These include the following:

- **Construct or upgrade critical infrastructure, such as roads, electricity and marketplaces.**
- **Promote aquatic foods as preferred animal-source foods.** Unlike terrestrial animals, the physiology of widely consumed aquatic organisms means that there is little chance of transferring viral zoonoses to humans.
- **Accord higher priority to capture fisheries in development planning processes.** This recognizes their importance as a “safety valve” for livelihoods and food and nutrition security during shocks such as COVID-19.
- **Invest in human capacity and skills development.** This should be done through training programs to support sectoral development in fisheries and aquaculture. This may include promoting production of nutrient-rich aquatic foods for household consumption to reduce food and nutrition insecurity in the face of shocks.
- **Support digitalization and digital literacy in aquatic food value chains.** This will facilitate advertising, marketing, input procurement, delivery of technical advice and payments.
- **Develop more comprehensive systems of social protection.** This will prevent large-scale slides into extreme poverty and food and nutrition insecurity when shocks occur in the future.

1. Introduction

Capture fisheries and aquaculture are a vital source of employment, income and nutritious food for millions of people in Africa and Asia. COVID-19 and policy measures to contain its spread have seriously disrupted food value chains due to disturbances in transportation, trade, labor mobility, logistics and temporary closures of institutions (e.g. schools) and places of business (e.g. markets, restaurants) (Reardon et al. 2020; Liverpool-Tasie et al. 2020; Pu and Zhong 2020; Sharma et al. 2020; Torero Cullen 2020).

Though important for protecting public health, emergency containment measures have contributed to a severe global recession that has depressed consumer spending power (Swinnen 2020). Between 90 million and 150 million people are predicted to fall into extreme poverty as a result. Most of these poverty increases will be in sub-Saharan Africa and South Asia (Laborde et al. 2020). This trend has already had dire consequences for food and nutrition security. The number of people experiencing extreme food insecurity increased by an estimated 45 million from February to June 2020 alone (Global Panel 2020). Low-income consumers spend a large share of their earnings on food and are likely to substitute relatively cheap staple foods such as rice or maize for more costly nutritious non-staples, including aquatic foods like fish, when incomes decline (Headey and Ruel 2020). These trends are rapidly undermining decades of progress on key human development indicators, including the UN's Sustainable Development Goals (HLPE 2020).

The COVID-19 pandemic is a systemic shock that affects all areas of the global food system. A growing range of impacts on aquatic food¹ producers, value chain actors and consumers is evident. This includes disruptions to international trade in aquatic foods, reconfiguration of domestic food value chains, exposure of fishers and seafood processing workers to COVID-19 infection (Love et al. 2021), immobilization of migrant fishers and fishworkers (Marschke et al. 2020), delays in accessing critical production inputs for aquaculture such as broodstock and seed (Kakoolaki et al. 2020; Kumaran et al. 2021), changes in levels of fishing pressure (Stokes et al. 2020), fluctuating consumer and producer prices, changing product preferences, and reduced levels of production (Love et al. 2021; Bennett et al. 2020; Campbell et al. 2021).

Taking into account these emerging patterns, we hypothesized the following:

1. COVID-19 and associated containment measures will disrupt aquatic food value chains, affecting the supply of production inputs, labor and transport/logistics.
2. COVID-19 and associated containment measures will inhibit the mobility of workers and consumers and reduce employment and incomes. This will lead to lower demand for aquatic foods and lower derived demand for aquatic food production inputs, such as feed and fish seed.
3. Combined supply and demand side shocks will affect availability and prices of aquatic foods and inputs for aquatic food production. Depending on the circumstances, these effects may be short term (e.g. due to hoarding by consumers) or longer term (e.g. due to delayed stocking of ponds by farmers). They might also drive prices up (e.g. due to inability to access production inputs) or down (e.g. due to sluggish consumer demand for aquatic foods).
4. The confluence of points 1–3 will drive adaptations in the behavior of actors in aquatic food value chains and reconfigure the structure of these chains, such as through the accelerated diffusion of e-commerce (Reardon et al. 2021)
5. Effects will be spatially and temporally uneven. They will be shaped by place-specific contexts that include COVID-19 infection rates, stringency of policy responses and seasonality of production. Effects will also be socially uneven, shaped by factors like gender, economic status, type and scale of business operations, and degree of political influence.

Over the course of 2020, we tracked the impacts of the COVID-19 pandemic and associated policy responses on the availability and price of aquatic foods and production inputs across the entire aquatic food value chain in three Asian and two African countries (Bangladesh, India, Myanmar, Egypt, Nigeria). To gain further insight into how the effects of the pandemic were experienced and how those affected adapted, we conducted semi-structured phone interviews with 63 respondents in Bangladesh and online interviews with 100 aquatic food value chain actors and key informants from 17 sub-Saharan African countries.

The results provide insight into the pathways by which aquatic food value chain actors have been affected by the crisis to date. These results give rise to policy recommendations aimed at mitigating impacts in the present, assisting recovery and building a more resilient aquatic food system in future. Public health interventions continue to play an important role in saving lives, but the deepening economic crisis demands a renewed emphasis on protecting livelihoods and human nutritional status. We contend that the revitalization of aquatic food value chains can contribute to these goals and that they can be mutually reinforcing.

The remainder of the paper is organized as follows: First, we present the survey methodologies. Second, we summarize information on rates of COVID-19 infection and the stringency of COVID-19 policy responses in each of the five countries included in the high frequency survey. Third, we present quantitative findings on supply side and demand side shocks, prices and availability of aquatic foods and production inputs, and qualitative findings on actor responses. We conclude with immediate and longer-term policy recommendations to support a fast and equitable process of recovery in which aquatic foods and aquatic food value chains play a central role in supporting livelihoods and food and nutrition security in Asia and Africa.



Socially distanced fish seed sales at a hatchery in Myanmar.

2. Methodology

2.1. Survey

We conducted a multi-country survey of aquatic food value chain actors (n=767 in eight value chain nodes), from February to October 2020, in three Asian countries² (Bangladesh, India and Myanmar) and two African countries (Egypt and Nigeria). These countries were selected because of high levels of aquatic food production and consumption and the presence of WorldFish offices. In India, we conducted three separate surveys, covering the states of Andhra Pradesh, Assam and Odisha.

Health precautions and movement restrictions made it impossible to visit the field to select survey respondents. Respondents were therefore identified from existing contacts of WorldFish country offices, with additional snowball sampling where necessary. Care was taken to include actors operating at a range of scales, drawn from major aquatic food producing and consuming areas in each survey location, and to include a mix of women and men respondents. The sampling technique means that survey results can be considered indicative of broad temporal trends but are not nationally or sub-nationally representative.

Survey implementation took place in two stages. The first round was implemented in May and covered the months of February, March and April. Recall data for February was collected to provide a pre-pandemic “benchmark” for assessing subsequent months. From May to June and onward, data was collected from the same set of respondents on a fortnightly or monthly basis, with each interview covering the period of the preceding calendar fortnight or month, respectively. Extra questions were added to the survey instrument at the beginning of this second phase, but the questionnaire remained unchanged afterward. To incentivize continuous participation in the survey, respondents were provided with mobile phone top-up credit, worth approximately USD 2 following each completed interview. Where respondent attrition occurred, efforts were made to find replacement respondents with similar characteristics.

Surveyed actors included hatcheries (78), feed mills (26), feed sellers (95), fishers (131), farmers (233) traders (85), processors, mainly comprised of fish driers or smokers (39), and retailers (78). The combination of value chain segments and total number of respondents interviewed varied slightly between survey locations, reflecting the types and numbers of actors present. In each location, enumerators conducted the survey by telephone and recorded responses using the KoBoToolbox digital data collection platform. Where relevant, the questionnaire was translated into the local language. The questionnaire structure was standardized across the countries to compare results directly, but with some country-specific response options, such as species of fish and types of feed.

The survey instrument was divided into two parts: a general section and an actor-specific section. In the general section, respondents were asked a common set of questions about employing workers, and access to inputs, transportation and buyers. The second section was comprised of questions specific to the type of business the respondent operated. These included number of days operated and reasons for any suspension of operations, as well as the quantity and value of inputs procured and/or products produced or sold, which varied by type of value chain actor. Data was first cleaned and then analyzed using the Microsoft Power BI platform, allowing results to be presented online in an interactive format for public use. The complete survey results can be accessed [here](#).

2.2. Qualitative interviews

We implemented a qualitative phone survey of aquatic food value chain actors in Bangladesh to capture more nuanced details on the context in which observed trends from the multi-country structured survey were embedded. A semi-structured interview guide consisting of 10 groups of open-ended questions was designed to capture information of how COVID-19 had impacted participants’ occupations, businesses or livelihoods, and their adaptations to these changes, impacts on their food consumption and the nature of any assistance or support received.

Telephone interviews were conducted in two rounds, in May and September 2020. A list of potential participants was generated based on the prior contacts of the research team and then recruited by phone. During the first round, 44 participants (39 men, 5 women) were selected purposively to capture a diversity of actor types, sizes of business operation, and geographical locations.³ During the second round, all respondents from the first round were re-interviewed and an additional 18 women and one man were recruited and interviewed, totalling 63 participants.

2.3. Online survey and key informant interviews

Simultaneously, we conducted a survey with 100 respondents working in aquaculture across 17 sub-Saharan African countries. During May, invitations to participate in the survey were posted on social media platforms, including the Sustainable Aquaculture Research Networks in Sub Saharan Africa Facebook [page](#). Respondents self-selected themselves as survey participants. Twenty interviews were conducted online or by phone. However, this approach proved difficult due to connectivity and language issues, so a short online survey form was fielded, and answered by 80 respondents from mid-June to mid-July. Survey design was coordinated to include questions covering topics similar to those in the two surveys described in sections 2.1 and 2.2.

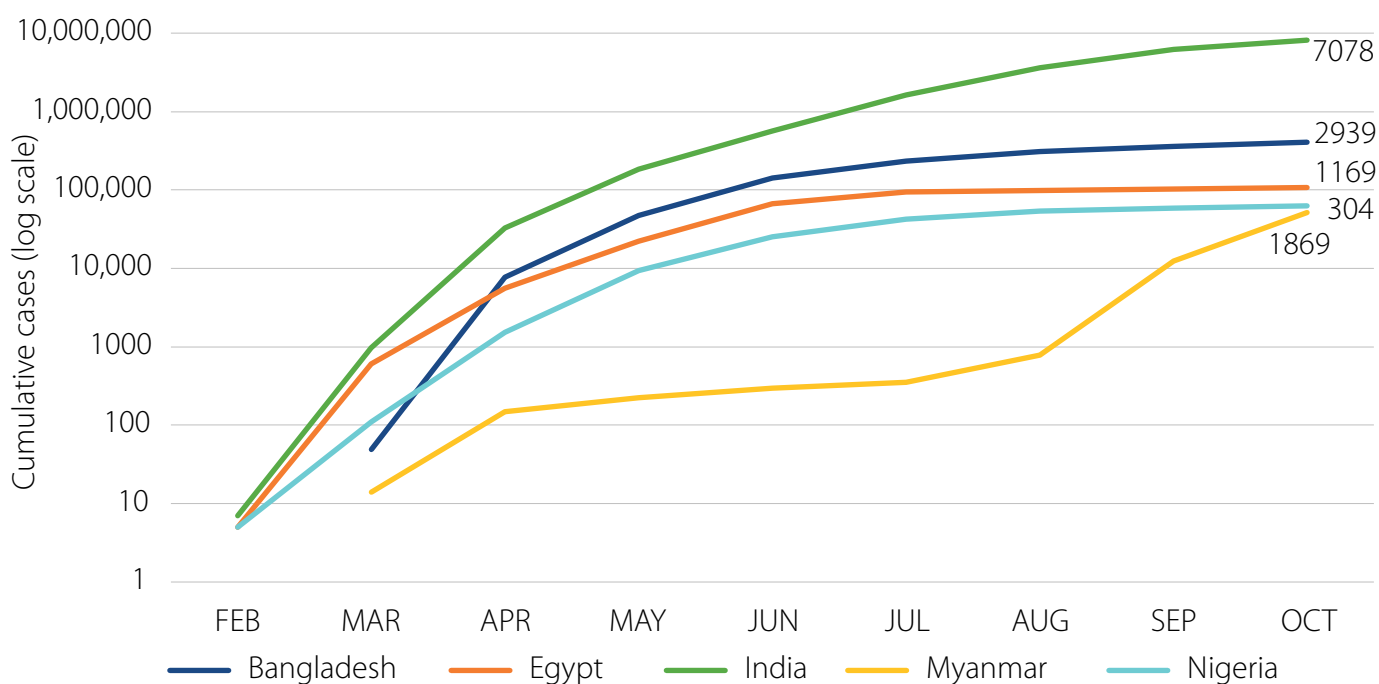


Smallholder farmer (in pink top) undergoing COVID-19 health guidelines before aquaculture training with WorldFish in Mbala District, Northern Province, Zambia.

3. COVID-19 pandemic impacts and policy responses in surveyed countries

The COVID-19 pandemic spread rapidly throughout the world after it was first recognized in China in December 2019. COVID-19 was first recorded in India in January 2020, in Egypt and Nigeria in February, and in Myanmar and Bangladesh in March (Figure 1). Reported cases initially increased fastest in Bangladesh, Egypt and India. Case numbers gradually stabilized from July in Bangladesh, Egypt and Nigeria, but continued to rise fast in India. Infection rates were initially low in Myanmar but increased sharply from August. By October, India had by far the highest rate of reported infections among the five countries (7078 per 100,000 inhabitants) and Nigeria had the lowest (304 per 100,000). Bangladesh, Egypt and Myanmar had intermediate levels (approximately 1000 to 3000 per 100,000).

Governments instituted a variety of containment policies and economic interventions intended to mitigate the impacts incurred by the pandemic and associated restrictions. Containment policies included a mix of phased full and partial “lockdowns” implemented at national (e.g. in India) or sub-national (e.g. in Myanmar) scales. To slow the rate of transmission, restrictions were placed on the movement of people, such as air travel and inter-state or intra-state road transportation. Businesses and institutions, such as markets and schools, were severely curtailed, as were social gatherings, like weddings, funerals, religious and sports events.

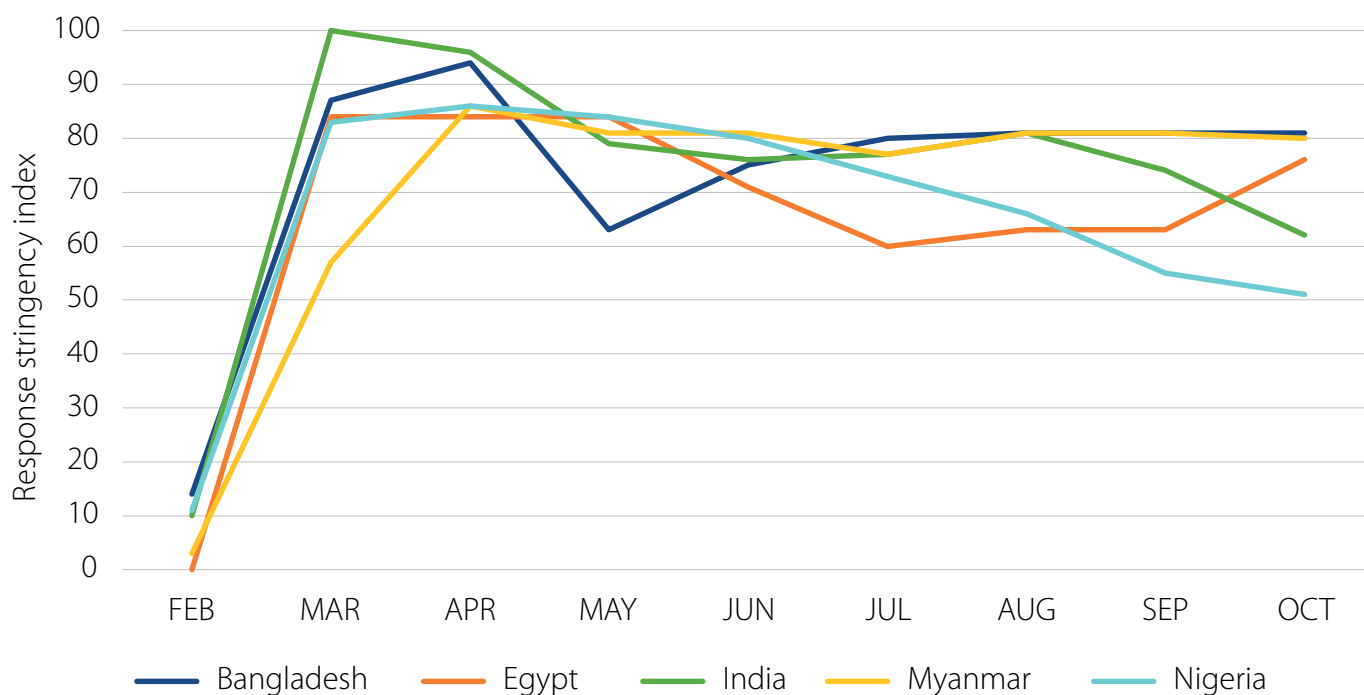


Note: Cases per 1,000,000 inhabitants in **bold** to the right of graph, as of the end of November 2020.
 Source: <https://covid19.who.int/>

Figure 1. Cumulative COVID-19 cases by country, February–October 2020.

The stringency of the application of these measures varied between countries and over time, as measured by a “response stringency index” (100 = most stringent). The index peaked in April and declined at different rates afterward in most countries (though it remained high in Myanmar where cases increased rapidly from August onward). This reflects the policy choices made based on infection rates and economic and political considerations (Figure 2).

Economic policies introduced to mitigate impacts incurred by the pandemic and the moves to contain it mainly took the form of (1) economic stimulus policies targeting sectors of the economy such as exporters, (2) financial relief for businesses in the form of loans, debt relief or restructuring, and reduced fees and taxes, and (3) forms of social protection, such as cash transfers to vulnerable households.⁴ However, our results (section 4) suggest that the reach of such programs in the countries surveyed has been patchy, and the amount of money disbursed often small.



Source: <https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker>.

Figure 2. COVID-19 response stringency index rating by country, February–October 2020.

4. Results

The results are structured in alignment with the hypotheses set out in the introduction. We compare selected results across surveyed countries and value chain nodes to identify common patterns and divergence. First, we evaluate general disruptions to aquatic food value chains, in terms of access to production inputs, buyers, transport and employment. Second, we assess the impacts of these disruptions on prices and traded quantities of aquatic foods and inputs for aquatic food production. Third, we examine evidence of adaptive behaviors by actors in aquatic food value chains and how these are shaped by social and economic status, drawing on the qualitative survey findings.

4.1. Disruptions to aquatic food value chains

4.1.1. Purchasing and sales behavior

Our first indicator of value chain disruption is the share of respondents reporting whether they attempted to purchase inputs or sell products in each month (Figures 3A and 3B). The largest impacts occurred in March and April during the height of lockdown restrictions. Nigeria and India were most severely affected; the share of respondents attempting to purchase inputs fell by 65 and 35 percentage points, respectively, as compared to February. In both countries, this share did not reach or exceed pre-pandemic levels until August. Bangladesh recorded a similar though less

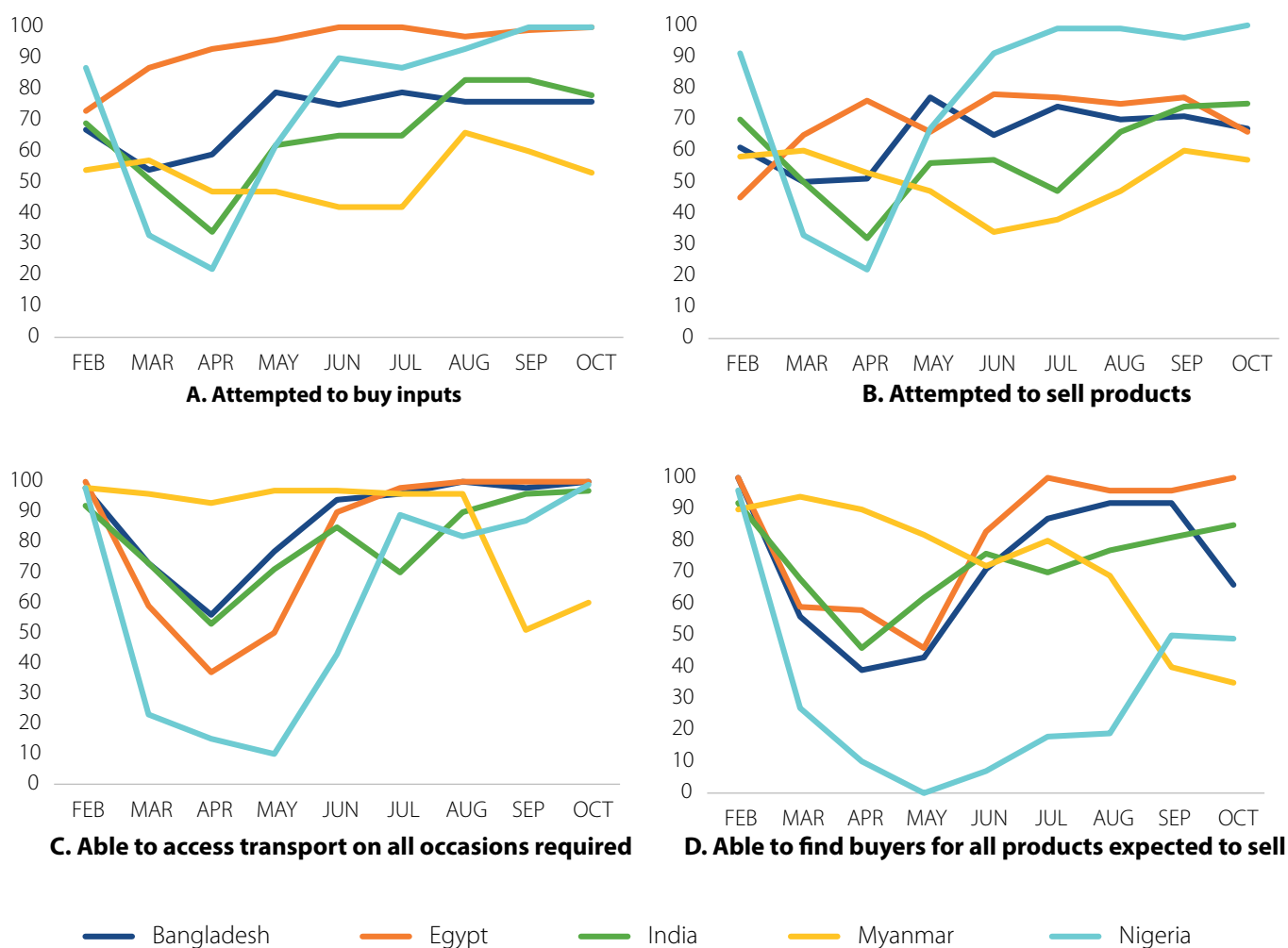


Figure 3. Purchasing and sales behavior among respondents, February–October 2020 (%).

pronounced trend, with a smaller initial drop in business activity and a quicker recovery. Impacts in Myanmar were initially rather limited but trended gradually downward in July to about 20 percentage points below February’s level, before recovering in August. Egypt followed the opposite pattern, with the share of businesses attempting to purchase inputs rising 25 percentage points between February and June. This trend reflects the relatively low incidence of COVID-19 infections in Egypt relative to other countries, and the highly seasonal nature of farmed fish production there, with production increasing from March onward as temperatures rise. In all five countries, the share of businesses attempting to sell products followed a similar temporal pattern to those attempting to buy inputs.

4.1.2. Access to buyers and transport

The ability to find customers is essential for businesses to continue their operations. We use the share of respondents able to find buyers for all the products they expected to sell as an indicator of access to customers. Mobility and access to transport for both buyers and sellers, as well as the level of demand from customers, can mediate businesses’ access to customers. This dynamic is reflected in Figure 3D. The ability to find buyers follows a similar temporal pattern to the ability to access transport, but access to buyers is more deeply impacted and somewhat slower to recover than access to transport. By September, the

share of businesses able to find buyers whenever anticipated had returned to February levels in only Egypt and Bangladesh and fell again in Bangladesh during October. This suggests that lagged effects on demand persisted for several months after the most stringent rules imposed in response to COVID-19 were relaxed and/or that new effects set in over time.

4.1.3. Employment

Enterprises in aquatic food value chains are important sources of employment and wage income for large numbers of people wherever clusters of these businesses exist, and hired labor is an important input for many enterprises in aquatic food value chains (Bush et al. 2019). The share of respondents employing casual workers fell below “baseline” February levels in most months in every country except for one. In Egypt, the share of businesses employing workers increased over the course of the fish farming season, which runs from March to November.

On average across the five surveyed countries, the share of businesses employing male casual workers shrunk from 51% in February to 34% in April and then climbed gradually again to reach 45% in October. Twelve percent of surveyed businesses reported hiring female casual workers in February. This share shrank to 5% in May and remained static before climbing to 10% in October (Figure 4).

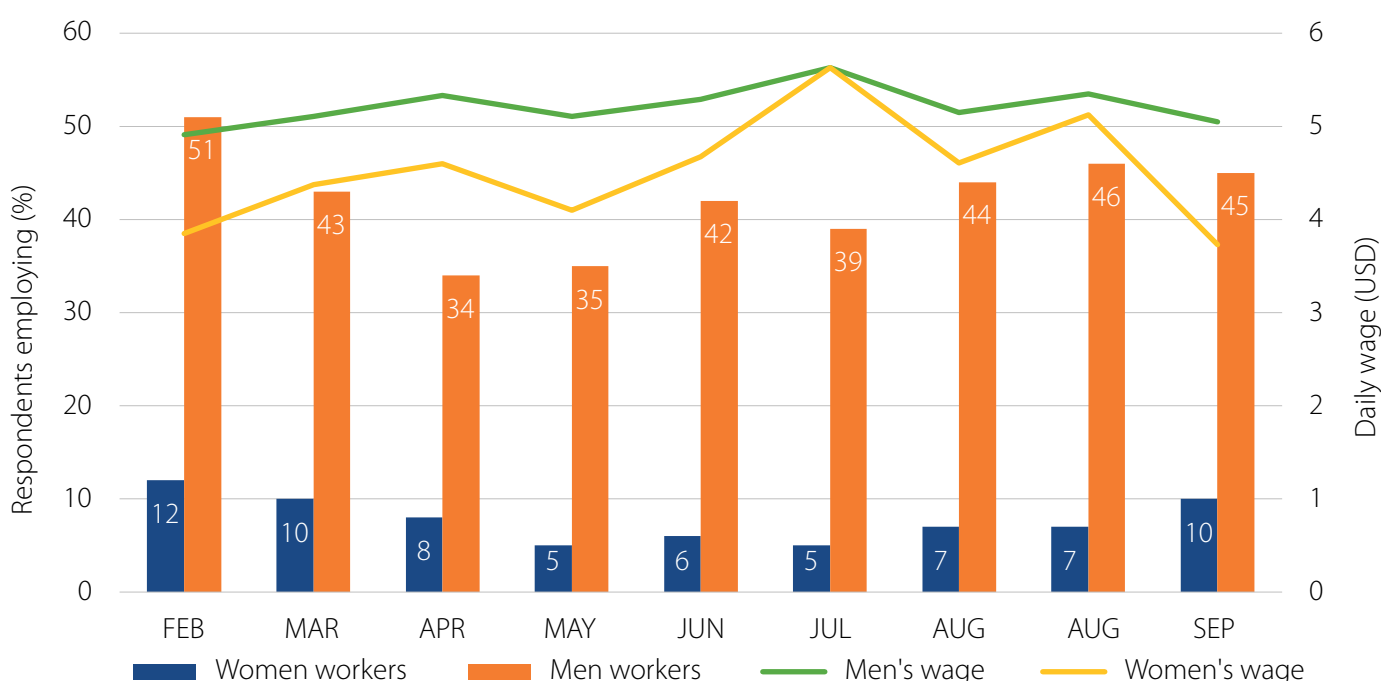


Figure 4. Respondents hiring male and female casual workers (%) and average daily wage paid (USD), February–September 2020.

These figures suggest that COVID-19 had gender-differentiated impacts on men's and women's ability to access paid work in aquatic food value chains, with women's employment more severely impacted than men's. Further research is needed to understand and address the reasons for this trend. However, one possible explanation relates to the greater burden of unpaid care work falling on women during the pandemic, especially in the form of care for children removed from school as part of containment responses (Power 2020; McLaren et al. 2020).

We asked respondents whether they had any difficulties hiring labor in the expectation that health precautions and movement restrictions could reduce worker availability. About 15% to 18% of respondents experienced difficulties finding workers when needed between March and May, falling to 8% by October (similar to February levels), indicating that this was a temporary issue. This suggests that lower than usual rates of employment after May were mainly the effect of reduced demand for labor from businesses as they experienced reduced turnover or attempted to cut costs, with implications for the vulnerability of workers in these value chains.

Average nominal daily wages paid to workers climbed to a peak in July (15% higher than February levels for men and 43% higher for women). Wages then declined to about February levels in October, when they stood at USD 5.05 and USD 3.73⁵ daily for men and women respectively—a large gender wage gap of 35%. Interestingly, reported daily wages for women workers converged with men's in July, possibly reflecting the retention of more skilled women workers and the shedding of less skilled positions. However, wages between women and men diverged again when rates of employment rose.

4.2. Impacts on the availability and price of aquatic foods and production inputs

In this section, we summarize key results on quantities and prices of aquatic foods and production inputs traded in the five countries, from February to September 2020. For comparability, we normalized all values by creating indexes in which February represents the base month for each country, with a value of 100. Deviations above or below this value

in subsequent months can be interpreted as percentage changes relative to the value in the base month.

In keeping with our value chain approach, we first analyze prices and sales volumes of farmed fish, by country, in three value chain segments: upstream (farms), midstream (traders) and downstream (retailers). We focus on farmed fish because it accounted for the bulk of fish produced and traded by respondents in the sample, making cross-country comparisons possible. We then analyze aggregate trends in the quantity, value and price of selected inputs and products procured, produced or sold by value chain actors, including fishers, fish processors, hatcheries, feed mills and farms.

4.2.1. Fish prices

The following observations stand out. First, in most countries, prices that fish farmers and traders received in most months were lower than before the onset of the COVID-19 crisis (Figures 5A and 5B). Minor exceptions are Bangladesh and India, where farmgate prices exceeded those in February in 4 and 3 months, respectively, but by less than 20% in all but one case. In Nigeria and Myanmar, prices that traders received exceeded those received in February by a small margin in 3 and 2 months, respectively. For all other countries and months, farms received between 5% and 35% less for fish sold than they had done in February. Across all countries and months, farmgate prices averaged 10% less than in February, with prices in India and Myanmar affected most strongly. A similar pattern is apparent for fish traders. Indian trader prices were affected particularly severely, averaging about half of February levels in most months. Across all countries, traders' sales prices averaged about 15% less than in February. This pattern is likely an effect of the slow demand evident in Figure 3D, transmitted upstream from consumers, through marketing intermediaries, to producers.

Second, retail prices spiked during the first months of the pandemic but fell from June onward (Figure 5C). Retail prices rose by about 15% in most countries, and as much as 45% in Nigeria during the peak lockdown months from March to May. Divergence between producer and retailer prices during these months likely reflects increasing transport costs, paralleling difficulties in accessing

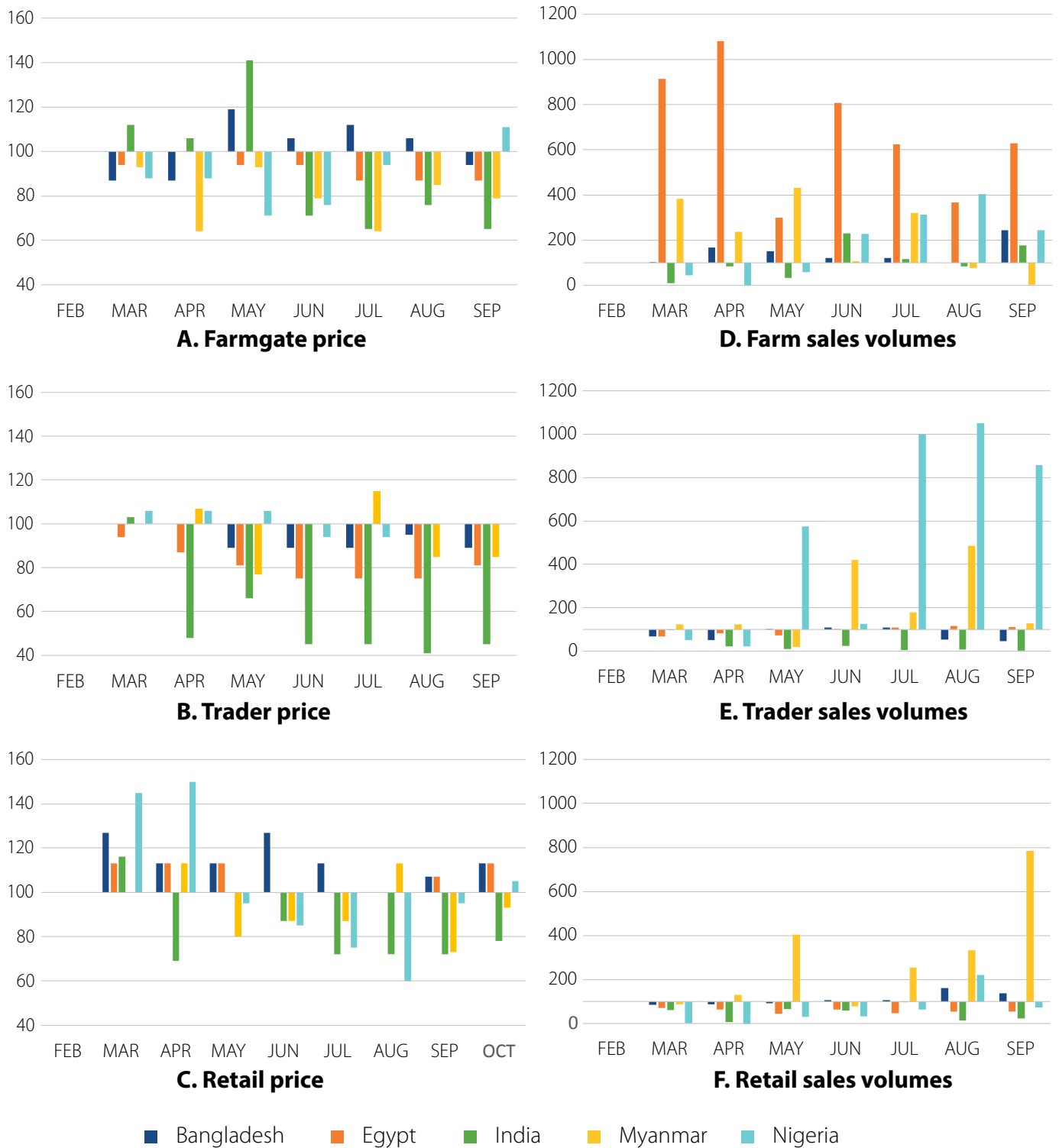


Figure 5. Monthly farmed fish price indexes and monthly farmed fish sales indexes, February–September 2020.

transportation (Figure 3C), as well as restrictions on wet market operations and consumers’ tendency to stay home, heightening the chance of fish remaining unsold and becoming spoiled (Liverpool-Tasie et al. 2020). These costs and risks were likely passed on to consumers, some of whom may have been willing to accept them due to the reduced set of retail options available. However, in most months from June onward, in most countries except Bangladesh, retail prices fell below February levels. This indicates that demand remained depressed after restrictions

on transport and business operations eased, which is consistent with Figure 3D. Egypt is a partial exception, with retail prices in June, July and August unchanged relative to February.

4.2.2. Fish sales

We observe the following patterns for sales of farmed fish: First, the trend in volumes of sales that fish farms made reflects the interplay of seasonality with the impacts of COVID-19 and

related containment policies. The seasonal effect is most evident in Egypt, where only 8% of farms sold any fish in the “base” month of February, before the onset of the COVID-19 crisis. Subsequent large increases in the farm sales index for Egypt reflect this low base, the ramping up of production and sales as temperatures rise in March, as well as the relatively moderate human health impacts of the pandemic in the country during this period. In Myanmar, fish sales by farms followed a similar, though less pronounced, pattern of high sales relative to February, but contracted in August and September with the emergence of a “second wave” of COVID-19 infections. Relative to February, volumes of fish sold by farms in India and Nigeria contracted in March–May. This likely reflects the severity of lockdown measures, such as restricted interstate movement and market closures, in both countries during those months. In most subsequent months, however, sales volumes exceeded February levels, especially in Nigeria (Figure 5D).

Second, the trader and retailer sales index for farmed fish fell in most countries and months, supporting the inference that consumer demand remained sluggish. In all countries except Myanmar, trader and retailer sales in March and April were lower than in February. This finding likely reflects the stringency of lockdown measures and incidence of COVID-19 infections, which were higher in Bangladesh, India, Egypt and Nigeria during these months than in Myanmar (Figures 1 and 2). The trader and retailer sales indexes remained above February levels in Myanmar in most subsequent months. In Nigeria, the trader sales index increased up to 10 times between May and September, compared to February. But for all other countries in most months, trader and retailer sales remained below or close to February levels. India’s trader and retailer sales were particularly heavily impacted. On average, Indian traders reported selling about 75% less farmed fish in each month than in February, while retailers sold 45% less, suggesting that a dramatic reduction in fish consumption took place.

4.3. Production, procurement and prices

Figures 6A–C further illustrate the relationships between seasonality of supply and demand and COVID-19 impacts for fishers, processors, hatcheries and farms. Figures 6D and 6E present price trends for key feed mill and farm inputs.

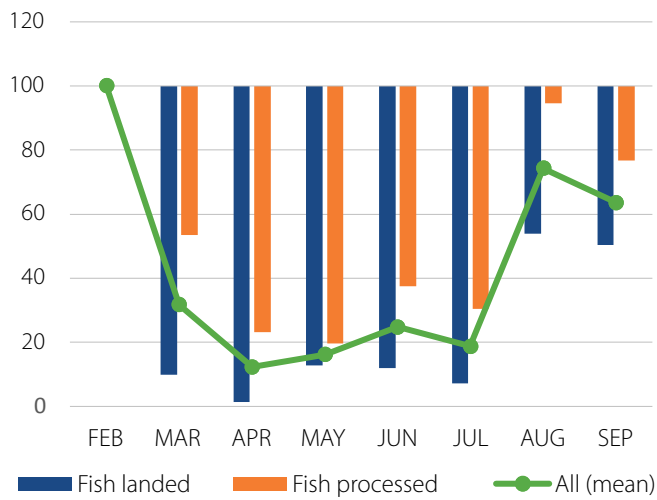
4.3.1. Production and procurement

Capture fisheries landings are highly seasonal. Stormy weather during the monsoon season often precludes fishing in small-scale marine fisheries. Myanmar, Bangladesh and states on the east coast of India enact fishing bans during April–June⁶ to protect spawning fish stocks. In these locations, “peak” fishing season runs from approximately October to April. Fish processing (meaning fish drying in the case of most survey respondents) is highly dependent on supplies of fish from capture fisheries, requires dry weather and follows a similar temporal pattern to fishing.

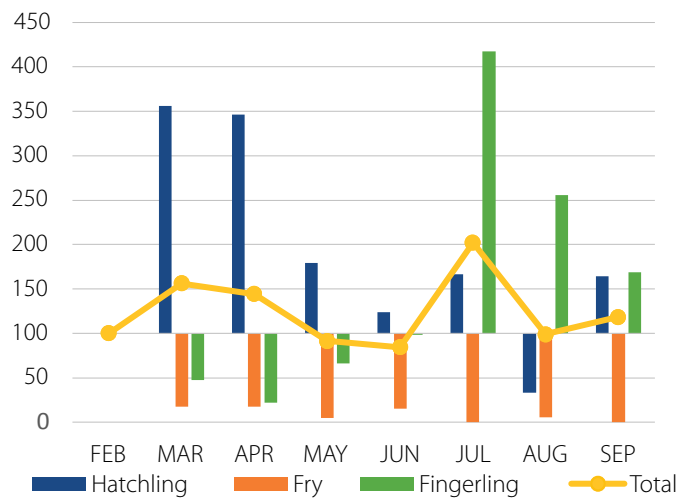
The low value of the index for capture fish landings and quantity of fish processed from May to July reflects seasonal tendencies, but the low values in March and April (usually months of high activity) are mainly attributable to COVID-19 impacts (Figure 6A). Respondents from both types of businesses cited temporary business closures due to COVID-19, restrictions on travel, and difficulties hiring transport among the major reasons for pausing operations in March and April. This is in contrast to the closure of the fishing season and bad weather as the reasons commonly reported from May to August.

Hatchery seed sales undergo two seasonal peaks, especially for hatcheries specializing in carp seed production: in March and April, when hatchlings (newly hatched fish) are sold to nurseries, and in July, when fingerlings (larger juvenile fish) are sold to farms. The timing of these peaks in activity is related to the timing of annual production cycles that are linked to seasonal variations in rainfall and temperature. Although these peaks in activity occurred at the usual time, reports from the field in Bangladesh and India indicated that they were low compared to previous years, causing some hatcheries to destroy large quantities of seed that they were unable to sell due to transport restrictions (Mamun et al. 2020; Shieh et al. 2020). The sales index remained close to February levels during subsequent months, indicating low levels of business activity, as February is low season for hatcheries most countries surveyed (Figure 6B).

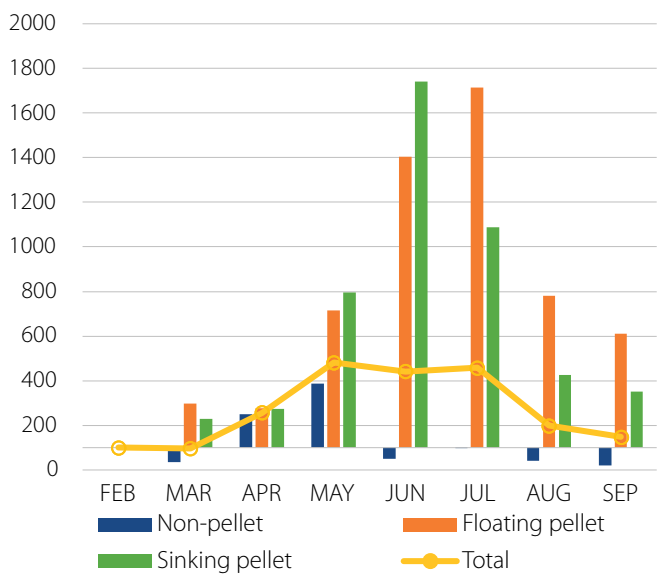
Feed procurement by farms reflects a similar mix of seasonal and COVID-19 effects. Low temperatures reduce fish metabolism, making February a quiet month for feed procurement in Egypt, India and Bangladesh. The feed procurement index



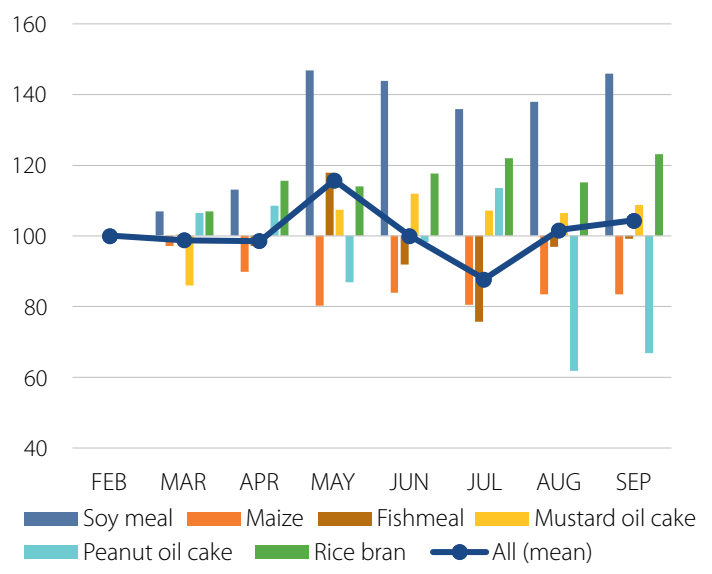
A. Capture fish landing and processing



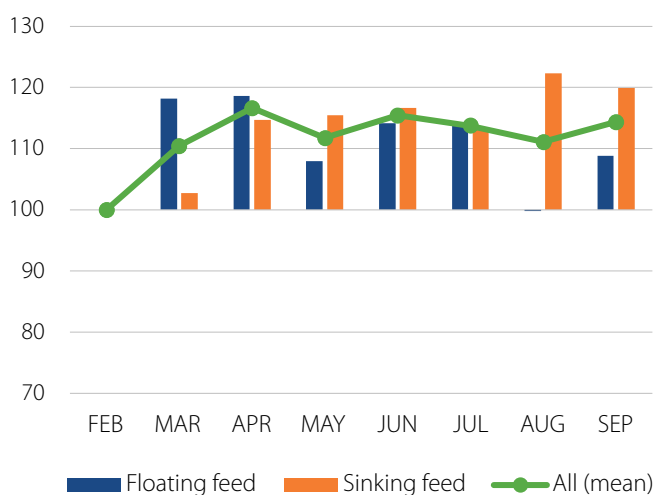
B. Hatchery seed sales value



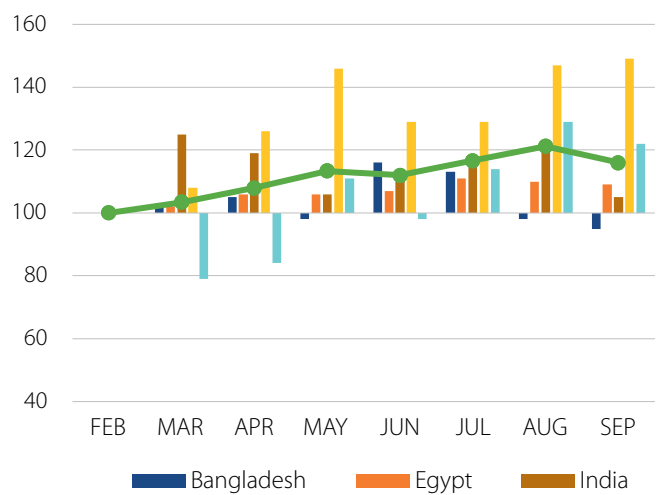
C. Farm feed procurement quantity



D. Feed mill raw material price



E. Feed mill feed sales price



F. Pelleted feed purchase price (farms)

Figure 6. Monthly all-country indexes, February–September 2020.

remained at relatively low levels during the peak lockdown months of March and April, even as temperatures rose. The procurement index for

non-pelleted feeds, such as rice bran and oil cake, reached its highest level during April and May. This might indicate that they were substituted

for more expensive pelleted feeds to reduce costs, an adaptation that farmers reported in our qualitative study in Bangladesh. The overall feed purchase index was about four times higher in May to July than in other months (Figure 6C). Peaks in the purchase of feed at this time are associated with the peak monsoon farmed fish production season in Asia and Nigeria, when nearly all ponds are stocked with growing fish. High levels of feed purchases during these months may also reflect farms making bulk purchases after transport restrictions eased—a strategy reported by respondents to our Bangladesh qualitative survey.

4.3.2. Input prices

Feed mills use a variety of raw materials for manufacturing pelleted feeds. Raw material prices remained relatively stable throughout the survey period. The price index did not deviate by much more than 20% above or below February levels for all raw materials except soy. The price index for maize and peanut oil cake trended downward in most months after February. Soy, rice bran and mustard oil cake prices exceeded February levels in most months. The fishmeal price index fluctuated (Figure 6D). Raw materials are procured from domestic or international markets or both, depending on local availability, price and quality, meaning that prices are influenced by both international and local conditions. The relative overall stability of raw material prices during this period reflects, in part, the lack of emergency restrictions on international trade during the crisis, which has helped to minimize price volatility for key staple crops, such as rice, maize and wheat (Moran et al. 2020).

Despite relatively stable prices for most raw materials, the mean price of feed that mills sold between April and September was 10%–15% higher than in February (Figure 6E). Farms also reported increases in the price of pelleted feed. The average farm procurement price index for pelleted feed rose about 20% from February to August. Price increases could reflect increased operating costs, including higher wage rates and transport costs. This inference was supported by respondents to our qualitative survey in Bangladesh, who noted that transport costs jumped 30% during lockdown and remained 10% higher than in 2019 following the relaxation of movement restrictions. Increasing prices of feed may also reflect high rates of inflation in surveyed countries during 2020 (Figure 6E).⁷

4.4. Impacts and adaptations

In this section, we review the impacts of the trends outlined in sections 4.1–4.3, with respect to incomes and employment, food and nutrition security, assistance (i.e. receipt of financial or other material support) and adaptive behaviors.

4.4.1. Incomes and employment

Higher input prices coupled with falling farmgate prices (as noted in section 4.2) suggest that farm earnings would have become increasingly squeezed over the course of 2020. Reductions in farming and fishing activity also reduced demand for labor, transport and other services during harvest, with significant negative outcomes for the many workers who depend on these activities. Qualitative interviews in Bangladesh show working hours declined 30%–40% and incomes decreased nearly 70% during the lockdown period for drivers employed in transporting fish and production inputs, due to lower fish and shrimp harvests and landings.

Income levels reported by farmers, fishers, businesses and workers in aquatic food value chains in Bangladesh typically improved post-lockdown but fell short of 2019 levels. For example, fish harvesting workers worked an average of 25–28 days and earned approximately USD 145–180 per month in May–August 2019. This plummeted to 8–12 days and USD 60 per month in March–April 2020, before recovering partially to 15–20 days and USD 90–95 per month in May–August 2020. Transport workers carrying fish, shrimp, crab and fish seed reported similar trends.

Many respondents in Bangladesh reported seeking supplemental work to cope. For example, an itinerant fish seed trader (*patilwala*) reported taking up day laboring to support his family due to the negative impact of COVID-19 on demand for fish seed, while a female wild shrimp post-larvae (PL) collector began working as a laborer on a crab farm to supplement reduced income from PL sales. Other respondents used savings or borrowed to meet their food consumption needs. Poorer respondents, in particular, expressed feelings of anxiety and helplessness in the face of uncertainty, inability to find work, and pressures around paying back loans. This strongly suggests that non-material dimensions of their well-being were also compromised.

4.4.2. Food and nutrition security

COVID-19's impacts on food and nutrition security varied widely by country. From May onward, we asked respondents whether the quantity of food their family purchased during the previous month was the same as, higher or lower than under "usual" circumstances. By this simple measure, food and nutrition insecurity was lowest in Egypt (where no respondent reported purchasing less than usual from July onward) and highest in Nigeria, where 55%–85% of respondents gave this answer in each month (Figure 7). Impacts were significant in Bangladesh and Myanmar, where between approximately one-quarter and half of respondents, respectively, purchased less food than usual each month. Myanmar is notable because this share trended up over time, reflecting the late onset of widespread COVID-19 infections and a second round of containment measures there. These figures suggest that the reduced financial viability of businesses in the aquatic food value chain has been linked to persistent negative impacts on food and nutrition security for many operators.

Qualitative interviews from Bangladesh provide additional insight into food and nutrition security during the pandemic. Effects on consumer behavior differed among lower- and higher-income consumers.

Actors in lower-income groups, including small-scale farmers and fishers, *patilwala*, drivers and laborers, described decreased dietary diversity and increased food and nutrition insecurity due largely to loss of work and income. Commonly reported coping strategies included skipping meals, eating less per meal, purchasing fewer food items, consuming fewer animal-source foods and/or eating greater quantities of more affordable staple foods. For example, a fish farmer described how her family had not eaten meat in a single meal in a month during the COVID-19 pandemic, a decline from their usual four times per month prior to this time. One fishing laborer explained that his school-aged children had to start working at the fish landing center to supplement declining household income and cope with increasing food and nutrition insecurity. However, some lower-income respondents reported being able to maintain normal levels of food consumption by producing part of their own food. For example, a dried fish retailer explained that her household was able to continue consuming fresh and dried fish from fishing, as well as vegetables grown on a small area of her own land.

In contrast, respondents with higher incomes, including operators of large hatcheries and feed mills and employees of seafood export companies, reported being able to switch to mobile applications for grocery shopping and delivery. They also described eating more nutritious foods,

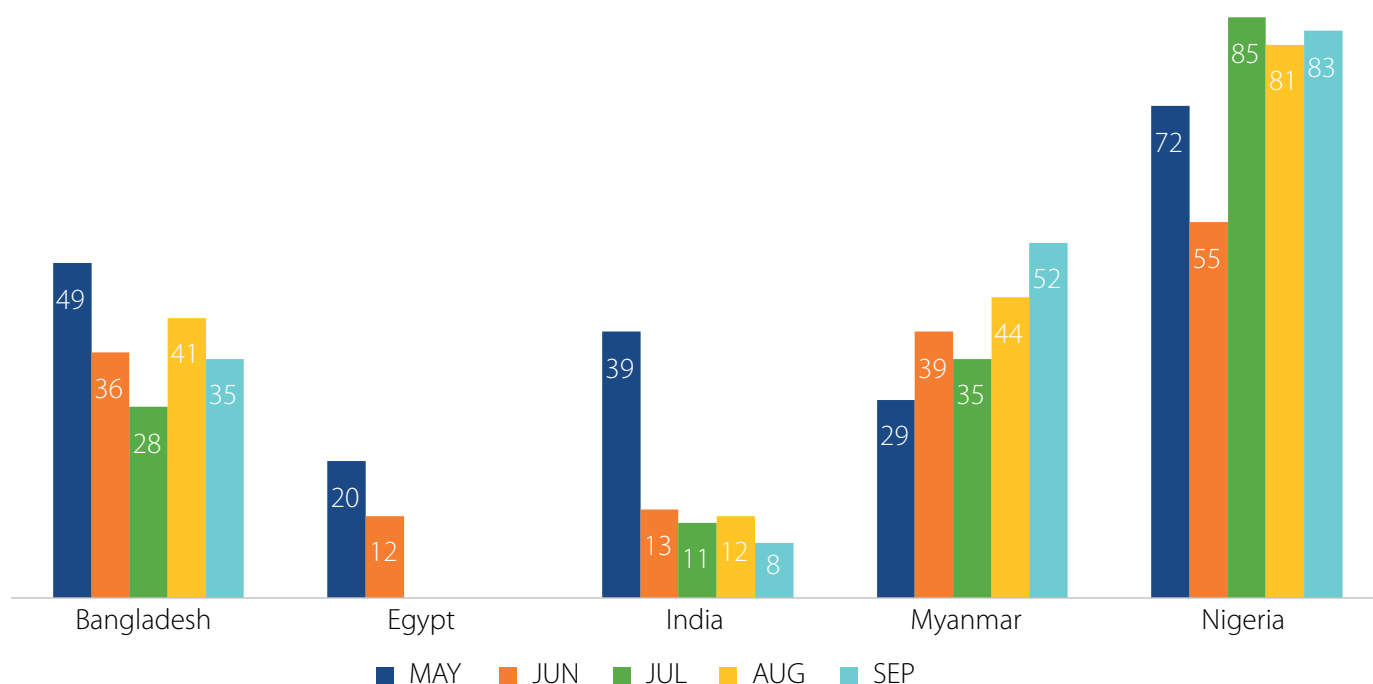


Figure 7. Respondents consuming less purchased food than usual, by month (%).

such as fruits rich in vitamin C, with the intent of boosting their immune systems. Better-off respondents also reported following food safety and hygiene practices, such as soaking vegetables and fruits in saltwater before consumption, which they believed would reduce the risk of COVID-19 infection. No low-income participants reported carrying out these practices, likely reflecting limited access to utilities such as running water and indicating their heightened vulnerability during the pandemic relative to groups with more resources.

4.4.3. Assistance

Beginning in May, respondents were asked whether they had received any form of assistance, like cash transfers or emergency food rations, from institutions such as government, NGOs, religious institutions or business associations. The share of respondents receiving assistance was very low in Bangladesh, Egypt and Nigeria. In Myanmar, rates of assistance were low from May–July, but jumped to 32% in August and 39% in September as the government implemented a cash transfer scheme during the country’s second lockdown (Headey et al. 2020). India had the most consistent rates of delivery, with 12%–24% of respondents receiving assistance each month (Figure 8). Government was the main source of assistance, but trade associations also played a significant role in India, accounting for 15%–35% of assistance in all but 1 month. Our online survey of actors in African aquaculture value chains produced similar

findings. Only 4% of respondents reported having received any assistance by mid-July.

Most of the assistance received appears to have been in the form of social protection transfers to households or individuals, rather than support targeted at businesses. A Bangladesh qualitative survey respondent opined that in the past, public funds had often been distributed inequitably, stating, “bank loans and benefits have always been for the musclemen of society, with less chance to reach the real entrepreneurs.” Other respondents felt that such funds might be difficult to obtain, or that informal businesses and enterprises without bank accounts could be ineligible to receive them. Low levels of information about and access to government loan programs for businesses were also reported by operators of integrated poultry-fish farms in Myanmar (Fang et al. 2020).

Many qualitative survey respondents from Bangladesh used informal support mechanisms to sustain their families, leveraging social capital with friends, relatives and/or wealthier actors in aquatic food value chains to cope with lost income or livelihood activities. For example, a driver explained that a local shopkeeper had allowed him to delay payment for his groceries. Fishing laborers and fish harvesters often took loans from fishers and farmers on condition of working for them in the following year, effectively selling their labor in advance, likely at discounted rates. Some operators of larger businesses reported

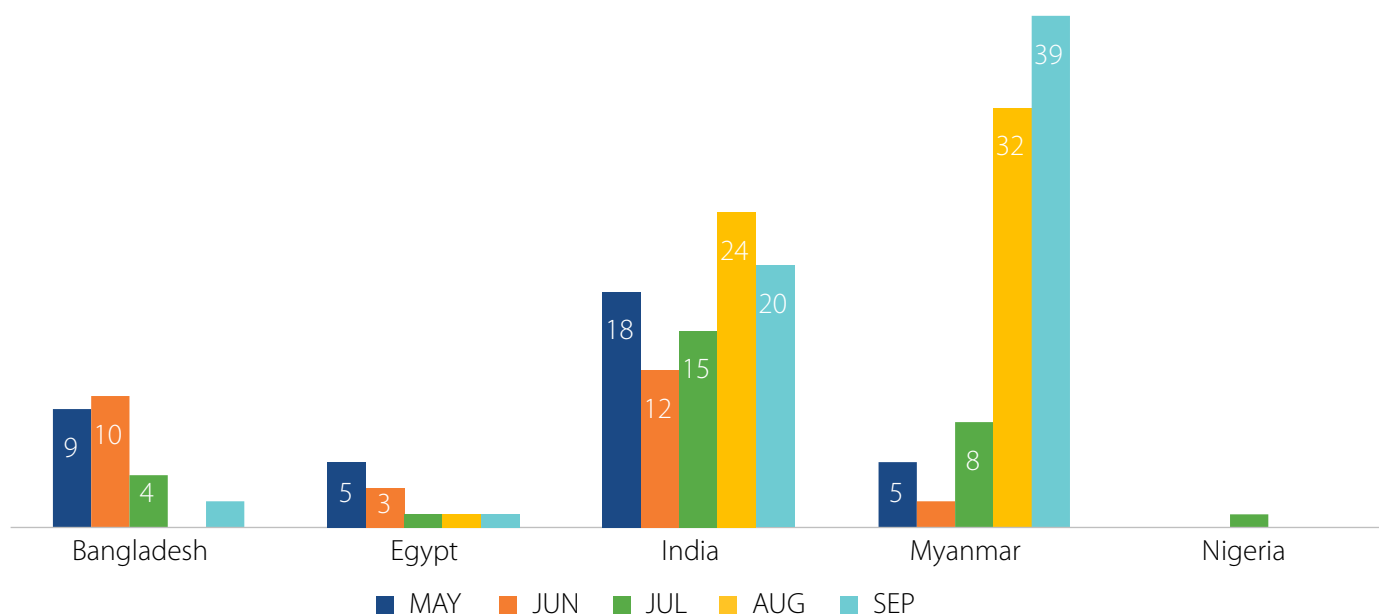


Figure 8. Respondents reporting receiving any assistance, by month and country (%).

providing food, financial assistance or loans to workers, neighbors and smaller enterprises during the lockdown period. These observations hint at the operation of local moral economies with somewhat ambiguous implications. While they are capable of providing a degree of social protection in the absence of state support, there is potential for exploitative consequences.

4.4.4. Adaptive behaviors

Qualitative interviews from Bangladesh and our online survey in Africa revealed that aquatic food value chain actors took a variety of adaptive measures to facilitate business operations. These can be categorized broadly as reactive or proactive.

Reactive adaptations focus on variable cost reduction or input substitution as a response to low demand for products and/or constrained supply of inputs. The most common reactive adaptations reported by respondents in Africa and Bangladesh include the following:

- temporarily pausing or reducing the duration of operations
- minimizing operating costs (e.g. by laying off or hiring fewer workers, paying lower wages, reducing input procurement, reducing harvesting and/or stocking rates, delaying the beginning or end of a production cycle, or using cheaper production inputs)
- sourcing alternatives to unavailable inputs
- buying in bulk and hoarding inputs
- selling products at discounted rates
- borrowing working capital
- paying bribes to facilitate continued operations.

Reactive adaptations are common, particularly for smaller enterprises with limited resources. Although often necessary for reducing losses, minimizing risks or overcoming constraints, these strategies tend to lower productivity and incomes. For example, hatcheries in Bangladesh used synthetic hormones after the price of imported carp pituitary gland from India rose several times, resulting in lower ovulation and higher rates of hatchling mortality. Also, feed mills and farms in Africa and Bangladesh used locally sourced raw materials or feeds of inferior quality and/or higher

price when imported products were unavailable. In another example, farmers in Bangladesh stocked hatchery produced shrimp PL, perceived to be of inferior quality to wild caught seed. Many actors in Bangladesh, including dried fish processors, hatcheries, *patilwalas* and feed retailers reported offering discounts or selling products at reduced rates to clear stock or generate sales.

During the lockdown in Bangladesh, confusion around the enforcement of movement restrictions, from which vehicles transporting fish and shrimp were officially exempt, often resulted in drivers having to pay bribes, raising transport costs. Similar findings are reported in Nigeria (Liverpool-Tasie et al. 2020). Selling assets was a drastic but relatively uncommon coping strategy, reported in one instance in Bangladesh where a small feed retailer sold land to cover business losses.

Proactive adaptations are innovations that fundamentally alter business operations, value chain structure, or relations between value chain actors, creating new opportunities or potential to improve performance. Adaptations of this type were most common among, though not exclusive to, larger businesses. Respondents in Africa and Bangladesh cited the following examples: (1) using digital platforms for marketing or procurement, (2) operational diversification, such as farms selling products directly to customers, offering delivery services or setting up retail operations, (3) institutional innovations, including coordination among shrimp hatcheries in Bangladesh to set a minimum price for PL, and (4) providing expanded trade credit to customers to maintain demand.

Other minor proactive adaptations include conducting business activities remotely (meeting online instead of face-to-face), placing orders by phone and following safety precautions, such as social distancing and providing personal protective equipment and hand sanitizers, to safeguard the health of workers and customers.

5. Discussion

Here we return to the hypotheses set out in the introduction and synthesize findings from our multi-country time series survey of aquatic food value chain actors and contextual interviews from Bangladesh and Africa. We find the following:

First, COVID-19 and associated containment measures severely disrupted aquatic food value chains across the countries surveyed, particularly via impacts on transport and logistics. However, most effects on the availability and accessibility of aquatic foods and production inputs were relatively short-lived.

Second, impacts on demand have been longer lasting due to lagged effects of lockdown measures and the ongoing COVID-19 health crisis. Demand for aquatic foods has yet to recover to pre-pandemic levels in the countries surveyed. As a result, derived demand for production inputs and services, such as seed, feed, transport and labor, also remains low. This resulted in substantially lower incomes for businesses and workers throughout the value chain as compared to 2019.

Third, except for a brief spike in retail prices during the lockdown period, aquatic food prices in all segments of the value chain trended downward over the course of the pandemic in the countries surveyed, reflecting depressed demand. Prices of most raw materials used for feed production remained relatively stable, in line with international agricultural commodity prices, but prices of manufactured feeds rose, reflecting increased costs of doing business and inflation. These trends may result in a deepening “squeeze” on the financial viability of producers and supporting value chain actors if demand does not recover. Based on trends observed in the countries surveyed, it seems likely that global aquatic food production contracted significantly in 2020 for the first time after decades of near continuous growth.

Fourth, aquatic food value chain actors reacted to these challenges in multiple ways. These included reducing production costs, using alternative inputs, leveraging social capital through informal networks, borrowing, seeking alternative

employment and reducing food consumption. While born of necessity and essential for enabling businesses and households to survive in the short to medium term, some of these coping strategies seem likely to undermine well-being and longer-term resilience (Béné 2020). It remains to be seen whether flexible strategies such as lowering input costs, subsistence food production, self-exploitation (e.g. practicing farming or fishing with very low returns) (van der Ploeg 2013) and survival-driven livelihood diversification (Ellis 1998) will enable smaller producers and others to persist in the short run prior to their ultimate recovery. Larger businesses appear to have greater capacity to adapt proactively. These advantages may deepen as the COVID-19 crisis continues, leading to concentration in some value chain segments (Reardon et al. 2021).

Fifth, there is a high degree of commonality in impacts and adaptations observed across countries, but with local conditions tempering outcomes. The stringency and timing of COVID-19 containment policy responses and the progress of the pandemic are critical factors, and these interact with seasonality in ways that can heighten or dampen impacts. The underlying robustness of the economy in which containment measures are implemented also appears to play an important role. Actors in Egypt and India seem to have recovered more quickly and fully than in Myanmar and Nigeria, while Bangladesh occupies an intermediate position. As widely observed elsewhere (Patel et al. 2020; Blundell et al. 2020), findings from Bangladesh show that COVID-19 has exacerbated pre-existing social and economic inequalities. Asset-poor respondents and those in precarious occupations are most vulnerable to financial, food and nutrition insecurity and health risks, with consequences that are highly gendered (Klassen and Murphy 2020).

Finally, the global COVID-19 pandemic has already reversed years of progress on key human development indicators, including poverty and food and nutrition security, with sub-Saharan Africa and South Asia affected most severely (HLPE 2020). Aquatic foods play a unique role in

diets in countries in both regions, as a leading source of relatively affordable and accessible nutrient-rich animal-source food (Thilsted et al. 2016). Aquatic food value chains also support livelihoods and generate employment and income for millions of women and men across the Global South, offering routes out of poverty for some (Bush et al. 2019). Prior to the COVID-19 pandemic, the dynamism of aquatic food value

chains and their potential to drive progress toward development goals made them attractive sites for investment and intervention by governments and development agencies. This potential makes renewed investments in aquatic food value chains and the livelihoods they support of even greater importance in the context of post-COVID-19 recovery efforts.



Photo credit: Kingdon Saha/ICP/fish

Traders and buyers maintaining social distance at the Baponibag retail fish market in Chandpur, Bangladesh.

6. Policy recommendations

In this section, drawing on the results presented in section 4, we outline policy recommendations to mitigate and support recovery from the ongoing shock of COVID-19. These are divided into supply side and demand side recommendations, and recommendations that are immediate (aimed at mitigating the ongoing shock) and longer term (aimed at resilient recovery).

6.1. Immediate, supply side

Immediate supply side recommendations fall into two groups: (1) ensuring the smooth functioning of aquatic food value chains and (2) providing emergency financial support to actors in them.

The first set of recommendations includes the following points:

- **Ensure that logistics (transport, storage), physical marketplaces and “lateral” value chains delivering inputs are designated essential.** They must also be exempt from movement restrictions and kept open and operating, with social distancing and sanitation provisions such as water and soap for handwashing and providing personal protective equipment to protect public health. This is the most fundamental condition for avoiding supply-side shocks (Liverpool-Tasie et al. 2020; BIFAD 2020).
- **Designate workers throughout aquatic food value chains as essential workers.** Special consideration should be given to mitigating the effects of containment policies on migrant workers, who make up a significant part of the workforce in many aquatic food value chains and can be particularly vulnerable to both lockdown measures and health risks (Marschke et al. 2020).
- **Ensure that rules governing containment policies are clearly formulated and publicized widely to maximize compliance and minimize rent seeking opportunities.**
- **Establish regular processes of consultation between government, fisheries professionals and relevant business associations at national and sub-national**

levels to quickly identify emerging problems in aquatic food value chains and agree on and implement remedies.

- **Avoid border closures and restrictions on imports or exports to help prices remain stable.**

The second set of recommendations is prefaced by the observation that emergency financial support to actors in aquatic food value chains has been very limited to date in the countries surveyed. Where such schemes are implemented, they should take into account the following:

- **Accord value chain actors such as traders, transporters, input suppliers, and processors the same priority as producers when allocating resources.**
- **Focus on small and medium enterprises, farms and fishers, as these are more labor-intensive (employing many more people) than large enterprises, and they account for the majority of food produced and traded (Reardon et al. 2020).**
- **Bailout programs that prioritize allocation of scarce resources to industry could exacerbate inequities rather than reduce them (Ahmed et al. 2020). To maximize impact, aid packages can be scaled progressively.** For example, when providing financial aid to farms, payments can be made on a sliding scale weighted in favor of smaller farms, rather than allocating a flat fee per unit area.
- **Financial support packages for business should be well advertised.** They must have transparent and simple application criteria and be designed in recognition that most aquatic food value chain enterprises are informal and often unbanked, making it necessary to devise inclusive application and distribution mechanisms.
- **Loan timing and duration should take into account seasonality, such as by scheduling disbursement around peak stocking season for farms, and repayment dates after final harvest.**

6.2. Immediate, demand side

In most of the countries studied, the reach of formal social safety nets appears to have been limited or patchy to date. Keeping value chains working is thus of paramount importance. Nevertheless, where implemented, safety nets play important roles in mitigating the impacts of shocks on the poor and vulnerable (Gilligan 2020). We observe the following:

- **Unconditional cash transfers targeted particularly to vulnerable and poor groups, including women of reproductive age, can increase consumption of nutritious aquatic foods and stimulate demand for their production.** Disbursement can be timed to coincide with the implementation of any forthcoming waves of lockdown measures, such as in Myanmar, or other periods of particularly acute stress, including cyclones and drought.
- **Aquatic foods such as dried fish can be included in food aid packages as nutritious, culturally appropriate, convenient and low-cost foods, and used as an alternative to nutritional supplements that also stimulate demand for production.**

6.3. Long term, supply side

Recommendations for the long term are aimed at revitalizing aquatic food value chains to protect livelihoods and human nutrition, contribute to post-pandemic recovery and promote resilience to other future shocks. These include the following:

- **The physiology of widely consumed aquatic organisms means that there is little chance of transferring viral zoonoses to humans (Bondad-Reantaso et al. 2020).** This is strong grounds for promoting aquatic foods as preferred animal-source foods, given the associations between livestock rearing and bushmeat consumption and the emergence of new infectious diseases (Tomley and Shirley 2009).
- **Construct or upgrade critical infrastructure, such as roads, electricity and marketplaces.**
- **Establish systems for real-time monitoring of the quantities and prices of aquatic foods and inputs produced and traded to track changes and support speedy interventions where necessary.**

- **Provide practical digital literacy training to actors throughout aquatic food value chains to support digitalization in aquaculture and fisheries to facilitate ease of advertising, marketing, input procurement, delivery of technical advice and payments.**
- **Invest in human capacity and skills development through training programs to support sectoral development in fisheries and aquaculture.** This may include promoting production of nutrient-rich aquatic foods for household consumption to reduce food and nutrition insecurity in the face of shocks.
- **Capture fisheries can play an important safety valve function during shocks such as COVID-19 but could be vulnerable to particularly heavy exploitation during such events (Fiorella et al. 2020; Stokes et al. 2020).** Fisheries should be accorded higher priority in development planning processes because of their importance for livelihoods and food and nutrition security.

6.4. Long term, demand side

On the demand side, revitalizing aquatic food value chains through the types of interventions described in section 6.3 will boost employment and income. This will contribute to demand for aquatic foods and other goods and services through production, consumption and employment links (Filipski and Belton 2018). The COVID-19 pandemic has widened existing inequalities and underlined the weakness of existing forms of social protection in many countries (Gupta et al. 2020). Over the long term, better developed and more comprehensive systems of social protection and public health care will be key to pre-empting rapid, large-scale slides into extreme poverty and food and nutrition insecurity when shocks occur (Gerard et al. 2020).

Notes

- ¹ The term “aquatic foods” refers to all foods captured or farmed in water. For the countries and value chain actors studied in this paper, aquatic foods are comprised predominantly of finfish and crustaceans.
- ² We also conducted regular interviews with 22 respondents in Timor Leste, but these are excluded from the results presented here due to the small sample size.
- ³ The sample was not gender balanced, in part because many businesses in aquatic food value chains in Bangladesh are run by men, and in part because the team implementing the survey found it difficult to recruit women respondents willing to be interviewed at length by phone. Attempts were made to ensure a more gender balanced sample in the second round of the survey.
- ⁴ See <http://fapda.apps.fao.org/fapda> and <https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19> for more country-specific details of policy responses.
- ⁵ Calculated using fixed April 2020 exchange rates to control for exchange rate fluctuations.
- ⁶ Exact timings vary by country.
- ⁷ Nigeria (12.9%), Myanmar (6.1%), Egypt (5.7%), Bangladesh (5.6%) and India (4.9%) (IMF 2021).

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The CGIAR Research Program on Fish Agri-Food Systems (FISH) is a multidisciplinary research program. Designed in collaboration with research partners, beneficiaries and stakeholders, FISH develops and implements research innovations that optimize the individual and joint contributions of aquaculture and small-scale fisheries to reducing poverty, improving food and nutrition security and sustaining the underlying natural resources and ecosystems services upon which both depend. The program is led by WorldFish, a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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