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How has the COVID-19 pandemic response impacted small-scale fish farmers in Bhutan?

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\textbf{ABSTRACT}

The COVID-19 pandemic and related policy responses have exacerbated global food and nutrition insecurity by disrupting supply chains and destroying livelihoods. Previous studies show that the impact has been particularly severe for poor populations with limited livelihood options, who already faced food insecurity before the pandemic struck. This paper describes how COVID-19-related policy responses have impacted low-income, subsistence-oriented fish farmers in Bhutan. Based on nationally representative data collected between November 2020 and January 2021, the paper documents the responses of 353 Bhutanese fish farmers to the altered operating conditions and market disruptions caused by COVID-19. Results indicate that these farmers' access to inputs such as fish seed have suffered substantial disruptions. However, on the output side of the supply chain, some farmers have made significant gains in terms of increased demand and higher fish prices in informal markets. Furthermore, the food security of most farmers has suffered minimal impact. Overall, Bhutanese fish farmers have proved to be robust to COVID-19-induced adverse outcomes relative to commercial aquaculture producers elsewhere. Small-scale, subsistence-oriented production of fish along with other crops has benefitted the Bhutanese fish farmers by shielding them from the negative economic outcomes associated with market shocks and by directly preserving their food security. Nevertheless, the fish farmers require critical support to access essential inputs and upscale or maintain production infrastructure, so that they can continue fish production during the COVID-19 pandemic and become more robust in the long run.

\textbf{1. Introduction}

The COVID-19 pandemic and associated policy responses have dramatically worsened food and nutrition insecurity across the world (Béné et al., 2021; Swinnen and McDermott, 2020b; The World Bank, 2021). There is evidence that the pandemic has caused a global increase in the number of people experiencing food crisis at IPC/CH Phase 3 level\textsuperscript{1} or worse from 24 million in 2019 to 40 million in 2020 (FSIN and Global Network Against Food Crises, 2021). The impact has been disproportionately severe for poor and vulnerable populations, including unskilled low-income actors in informal agri-food systems like smallholder farmers and petty traders (Béné et al., 2021; FAO, 2021a; ILO et al., 2020; Swinnen and McDermott, 2020a).

Several factors make the poor especially vulnerable to the adverse welfare impacts of the COVID-19 pandemic. First, because poorer people allocate a greater share of their income to food, the combined effect of reduced income and increased food prices has compelled them to reduce their dietary intake and to consume cheaper and less nutritious foods (IFPRI, 2021; Swinnen and McDermott, 2020a). Secondly, pandemic containment measures such as mobility restriction and social distancing have severely constrained labour-intensive activities like fresh produce production, thereby jeopardizing the poorer people's ability to earn income through their most important asset—physical labour (IFPRI, 2021; Swinnen and McDermott, 2020a). Other factors that have further undermined the welfare of low-income groups during the pandemic include their propensity to be overlooked by public livelihood support programmes and poor access to social protection mechanisms.

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\textsuperscript{1} This level of food insecurity is characterized by “above-usual acute malnutrition” and meeting minimum food needs “by depleting essential livelihood assets or through crisis-coping strategies” (FSIN and Global Network Against Food Crises, 2021). IPC and CH stand for Integrated Food Security Phase Classification and Cadre Harmonisé, respectively.

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programmes because of the informal nature of their economic activities and the ongoing disruptions in social safety programmes and health service delivery (Béné et al., 2021; Swinnen, 2020). As a result, poorer people have generally resorted to destructive coping strategies that include compromising dietary intake and quality; depleting savings and assets; and, in some extreme cases, child labour (Belton et al., 2021; FAO, 2021a; IFPRI, 2021; SNV and Wageningen University and Research, 2021).

As well as being a crucial food-producing activity, small-scale aquaculture contributes to several other United Nations Sustainable Development Goals (Hambrey, 2017). This activity sustains millions of poor and vulnerable people around the world by providing them with nutritious food, livelihoods, jobs and income (Allison, 2011; Belton et al., 2021; Filipski and Belton, 2018; Phillips et al., 2016). For many developing countries, small-scale aquaculture also is a key means of curtailing foreign exchange drain associated with seafood imports and producing nutritious animal protein without harm to wild fisheries (African Development Bank Group, 2016; Department of Livestock, 2019).

While COVID-19 does not affect fish, and consuming fish does not cause or spread the virus (FAO, 2021b), some policy responses can severely disrupt aquaculture supply chains and so inflict economic distress on the actors involved (Mangano et al., 2022). Disruptions and adverse economic outcomes can occur in several ways; for example, mobility and logistical restrictions can severely impair access to essential inputs such as fish seed and labour (Belton et al., 2021; FAO, 2020; Kumaran et al., 2021; Senten et al., 2021). Similarly, fish production may be delayed or suspended, or stocks may pile up in a counterproductive manner because of negative demand shocks and delayed harvest (Azra et al., 2021; Belton et al., 2021). The increased production costs due to higher input prices and the fall in farm incomes associated with fewer sales or lower farmgate prices may also mean that workers are laid off (Belton et al., 2021; FAO, 2021a; Hasan et al., 2021; Lebel et al., 2021). These adverse socioeconomic outcomes eventually undermine food security and threaten the overall wellbeing of vulnerable aquaculture supply chain actors such as small-scale producers (Belton et al., 2021; FAO, 2021a; Islam et al., 2021; Kumaran et al., 2021; Lebel et al., 2021; Mangano et al., 2022).

This paper describes the impact of COVID-19-related policy responses on low-income, subsistence-oriented fish farmers in Bhutan and how they have responded to the changing operating conditions created by those policy responses. We also report the pandemic’s impact on fish farmers’ food security and identify the government supports that would enable them to continue production during the pandemic and become more robust in the long term. We analysed primary data from a nationally representative sample of 300 small-scale fish farmers and discussed our findings in light of secondary contextual information from key informant interviews. Based on those findings, we highlight the merits of small-scale, subsistence fish production as revealed in a COVID-19-like scenario, noting how governments can enable low-income small-scale fish producers to reap substantial economic benefits from the ensuing local market conditions by providing focused support to boost production. Inferring from our findings, we make policy recommendations that would improve the performance of Bhutanese aquaculture producers during the ongoing pandemic and render them robust against similar future shocks.

The rest of this paper is structured as follows. In Section 2, we outline the salient features of Bhutan’s aquaculture sector and the Bhutanese government’s major policy measures and supports for aquaculture during the ongoing pandemic. In Section 3, we describe the survey methodology and data. In Section 4, we present and discuss our main findings and relate them to the existing literature. Finally, in Section 5, we make policy recommendations based on our findings and indicate possible directions for future research.

2. Background

2.1. The Bhutanese aquaculture sector

Aquaculture in Bhutan largely involves subsistence-oriented2 farming of cultivable carps in earthen ponds by agricultural households in rural areas. These are typically low-income households with a daily income of USD 2.5 in terms of 2011-prices (NR&DCA, 2018), which is barely above the global poverty line of USD 1.9 (The World Bank, 2015). In 2020, there were 506 carp farmers, operating in twelve of the country’s twenty Dzongkhags3 (NR&DCA, 2020); a majority of these farmers produce fish as part of an integrated farming system that also includes cereal crops and livestock (RNR Statistics Division, 2019). The typical fish production infrastructure comprises one or two backyard ponds, using water from a surface source. The dominant husbandry approach is semi-intensive; fish are reared on natural food available in the pond, with minimal application of crude non-commercial supplementary feed.

Production inputs are typically non-purchased items, including family labour, feed based on available vegetable matter and crop residues, and farm manure to enhance natural fish food availability (Dorji, 2017). The only purchased input is fingerlings, which farmers source at a highly subsidized price4 from government hatcheries. For most farmers, the fish production season spans the year from March/May to the following January/March. During the season, farmers rear fish seed, each weighing between 5 g to 10 g, to produce table fish, each weighing between 250 and 1000 g, depending on species, climatic conditions, and individual husbandry skills. While most Bhutanese fish farmers (> 80%) stock their pond with fish seed just once a season, some do so more than once. In the case of the latter, initial stocking of a first round of seed is followed by subsequent stocking to replenish the pond after a partial harvest or to supplement the initial stock if the farmer practises polyculture.5 Multiple stocking is generally practised by commercially oriented farmers with larger ponds (< 15%), who achieve an average productivity of 4.5 metric tonnes/ha/year (NR&DCA, 2021a).

Bhutanese fish farmers are completely reliant on the government for fish seed, which is supplied by two government hatcheries: the National Research and Development Centre for Aquaculture (NR&DCA) in Sarbang and the Regional Centre for Aquaculture (RCA) in Samdrupjongkhar (Fig. 1). The NR&DCA has a total annual production capacity of 4 million fingerlings and supplies to farmers in Tsirang, Dagana, Wangduephodrang, Punakha, Chhukha, Samtse, Zhemgang and Sarbang, while the RCA, with an annual capacity of 2 million fingerlings, supplies to farmers in Trashigang, Mongar, Pemagatsel and Samdrupjongkhar. In 2019, the NR&DCA and the RCA distributed 1.8 million and 0.9 million fingerlings, respectively, to their farmer clients (NR&DCA, 2021a). As the NR&DCA’s production capacity is higher, it sometimes provides fingerlings to RCA clients. Because fingerlings are highly perishable, they must be transported from hatcheries to fishponds

2 Most Bhutanese aquaculture farmers fit the characterization of subsistence-oriented farmers as described by RNR Statistics Division (2019) and Edwards and Demaine (1998). They are small-scale, produce fish mainly for self-consumption using mainly non-purchased farm inputs and family labour, and sell fish mainly through informal marketing without actively seeking to sell on the formal market (Dorji et al., 2022).

3 Six species of carps are cultivated in Bhutan. These are Common carp (Cyprinus carpio), Grass carp (Ctenopharyngodon idella), Silver carp (Hypophthalmichthys molitrix), Catla (Catla catla), Rohu (Labeo rohita) and Mrigal (Cirrhinus mrigala).

4 Dzongkha is the Bhutanese term for a District.

5 Bhutan government provides fish seed to farmers at 10% of the cost of production (NR&DCA, 2019). The average farmer spends around US$ 17 on fish seed per production cycle (Dorji et al., 2022).

6 At the government hatcheries, seeds of different species of fish are produced at different times of the year; for instance, common carp seed is produced in Feb-April while Rohu seed is produced in May-August.
with minimal physical disturbance and in the shortest possible time.\footnote{To protect fingerlings from physical shock and so increase their chances of survival, they are transported in clean oxygen-saturated water in double-layered polythene bags, which are kept inflated and taut using pure oxygen. Each 20-l bag contains approximately 7 l of water and 13 l of pure oxygen and holds 400–500 fingerlings.}

Under normal conditions, fish farmers in far-flung Dzongkhags like Samtse would therefore transport fingerlings from the NR&DCA via India, along the wide straight roads of West Bengal and Assam (green dashed line, Fig. 1).\footnote{This indicates a possibility for Bhutanese fish farmers to obtain fish seed from Indian hatcheries in Assam and West Bengal. However, communication with NR&DCA sources reveals that no fish seed from India enters Bhutan under normal circumstances (Livestock Production Officer at NR&DCA, personal communication, 4 July 2022).} Using this route shortens the trip considerably and subjects the fingerlings to less disturbance than the alternative domestic route over the winding and relatively narrower mountainous Bhutanese roads through Chhukha, Thimphu, Wangduephodrang and Tsirang (black dashed line, Fig. 1). For the same reason, farmers in Samdrupjongkhar and other Dzongkhags also use the Indian route when sourcing fingerlings from the NR&DCA.

For two reasons, Bhutanese fish farmers are also completely dependent on the government for extension inputs. First, because of the sector's subsistence-orientation and reliance on non-purchased inputs, the country's aquaculture input supply chain is underdeveloped.\footnote{Because of a small fish farmer population and subsistence-oriented production with reliance on non-purchased inputs, there is not enough demand to stimulate private sector investment in commercial fish feed and equipment.} For example, no feed mill in Bhutan could produce aquaculture feed at affordable prices, mainly because of low demand from aquaculture farmers and high production costs associated with importing raw materials (Livestock Production Officer at NR&DCA, personal communication, 4 July 2022). Consequently, government hatcheries and other actors are dependent on imported feed, and other inputs like nets must also be imported. Second, many Bhutanese fish farmers have a limited capacity to independently process the information and inputs they need. This is in part because their literacy levels are generally limited.\footnote{In the three major fish-producing Dzongkhags of Samtse, Samdrupjongkhar and Tsirang, 38% of the fish farmers had never been to school, and 45% had only 1 to 6 years of schooling (NR&DCA, 2018).} The government has therefore stationed at least one professional in every Gewog\footnote{Gewog is a Bhutanese term for the basic administrative and development block within a Dzongkhag. In total, Bhutan has 205 Gewogs.} to provide extension services that range from facilitating fish seed sourcing and transportation to preparing grant proposals to access government financial support.

2.2. Bhutan’s COVID-19 policy responses and their impacts

Bhutan recorded its first case of COVID-19 on 5 March 2020. In response, the government implemented the country’s first policy response on 6 March 2020 by closing schools and institutes in the Dzongkhags of Thimphu, Paro and Punakha and suspending tourism (Prime Minister’s Office, 2020e). Since then, Bhutan has implemented a range of other COVID-19-countermeasures that have the potential to impact the aquaculture sector. These include (i) the closure of the country’s international borders on 23 March 2020 (Ministry of Home and Cultural Affairs, 2020); (ii) a ban on imports of fresh meat, vegetables and fruits on 24 March 2020 (Ministry of Agriculture and Forests, 2020; Wangmo, 2020b); iii) several partial lockdowns and two national lockdowns (Prime Minister’s Office, 2020a, 2020b); and iv) special protocols for domestic travel originating in Dzongkhags bordering India (Ministry of Health, 2020). To visualize the impact of these policy
measures on fish production, Appendix A superimposes a timeline of key fish production activities on a timeline of major countermeasures. Those policy measures have disrupted food supply chain and economic activities in Bhutan, with significant adverse impacts on welfare and economic progress. For example, the ban on imports of meats, vegetables and fruits has deprived inhabitants of beef, onion, tomato and chilli, which are typical of the Bhutanese diet (Wangmo, 2021). Within the country, people from high-risk areas cannot travel to other areas without first completing a strict seven-day quarantine at the origin of travel; this requirement has made it extremely difficult to conduct business travels. Overall, Bhutan’s economic growth rate has fallen from a pre-COVID-19 average of 5.5% to a mere 0.9% in fiscal year (FY) 2020 (ADB, 2021). Although the agriculture sector appears to have gained from the pandemic, growing by 2.6% as a result of increased crop and livestock production (ADB, 2021), how the policy responses have impacted the aquaculture sector remains poorly understood.12

2.3. Government support for welfare and aquaculture production during COVID-19

To alleviate the socioeconomic crisis induced by COVID-19-related policy measures, Bhutan’s government has established a National Resilience Fund (NRF) of USD 0.4 billion (Tshering, 2020), which is equivalent to about 17% of the country’s GDP in 2019 (National Statistics Bureau, 2020). The NRF finances a range of social safety and livelihood support programmes, including the Druk Gyalpo Relief Kidu (DGRK)—initiated at the behest of His Majesty the King of Bhutan— which provides cash transfers of up to USD 161 to vulnerable Bhutanese households, with additional cash support of USD 107 for children (Tshering, 2020). Businesses have similarly been supported through monetary and fiscal measures (Prime Minister’s Office, 2020c). To alleviate food security issues caused by import restrictions, the government has sourced essential food items and facilitated doorstep deliveries (Tshering, 2020).

To help the economy to rebound from the disastrous effects of pandemic countermeasures and to gain robustness, the government has also commenced the implementation of a two-phase Economic Contingency Plan (ECP). While ECP-2 is currently being formulated, ECP-1 is already underway, with a budget of USD 60 million (Tshering, 2020). ECP-1 focuses on three sectors: agriculture, tourism and construction. In the case of agriculture, which includes aquaculture, ECP-1 has allocated USD 43 million to increase food production for improved self-sufficiency and income generation and improving agricultural marketing (Prime Minister’s Office, 2020d).

Regarding the support to aquaculture, the ECP-1 aims at increasing the country’s farmed fish production by at least 60 metric tonnes in the short term. To that end, USD 0.42 million has been allocated to support integrated fish and pork production. Farmers can access these funds to establish new fish production systems or to upscale or renovate existing ones. A further USD 0.16 million has been allocated to a state-owned enterprise to produce only fish (Prime Minister’s Office, 2020d). In addition to ECP-1 funds, fish farmers can access funds from the regular 12th Five Year Plan-aquaculture development budget; in the period from July 2020 to June 2021, farmers had already accessed USD 0.08 million of this fund to build new fish farms and renovate old ones.

The government has also provided various ad hoc supports to enable farmers to produce fish despite the pandemic restrictions. In November 2020, for example, mobility restrictions were relaxed for some farmers in Zhemgang, and a De-Suang13 escort (commonly called De-Suup) was provided to transport fish seed from the NR&DCA in Sarpang. Similarly, in December 2020, the NR&DCA facilitated continued fish production in Tsirang, Dagana, Punakha and Wangduephodrang by transporting fish seed from its hatchery to a halfway point, where the seed was collected by extension officials and fish farmer representatives; this way, fish farmers of said Dzongkhas did not have to undergo the mandatory seven-day quarantine in Sarpang. In June 2020, the government allowed the otherwise closed Indian route to be used to transport a consignment of fish seed from the NR&DCA to fish farms in Samdrupjongkhar.

3. Data

The primary data on 353 small-scale, subsistence-oriented Bhutanese fish farmers were collected through a phone survey. Using a structured questionnaire, the survey was conducted between November 2020 and January 2021 by trained enumerators at the NR&DCA. The survey was approved by the Tasmania Social Sciences Human Research Ethics Committee and the Department of Livestock of the Royal Government of Bhutan. The fish farmer survey data were supplemented with additional information collected independently by the NR&DCA in 28 key informant interviews with government extension officials, national and local government aquaculture development professionals and a corporate fish farm manager. This supplementary information served to clarify the key informants’ views on how COVID-19 had impacted fish production at Dzongkhag level, the response of aquaculture service providers and whether the government was doing enough to support aquaculture production during the pandemic.

The farmer survey drew on the NR&DCA database of active fish farmers in Bhutan. The study covered 11 of the 12 fish farming Dzongkhas (Fig. 1); Mongar was excluded because its fish farms had ceased operations when irrigation was disrupted by a flash flood in July 2019. To ensure that sample distribution reflected population distribution, more respondents were recruited from Dzongkhas with higher numbers of fish farmers (Table 1). The five Dzongkhas of Pemagatshel, Punakha, Trashingang, Wangduephodrang and Zhemgang were combined into an “Others” as they each had <10 respondents. This was done to protect the privacy of the farmers in these Dzongkhas by reducing the possibility to identify them individually.

Table 1

| Dzongkhang | Dzongkhang fish farmer population (Nos) | Percentage contribution to national fish farmer population (%) | Number of fish farmers recruited into sample (Nos) | Percentage of population sampled (%) |
|------------|----------------------------------------|-------------------------------------------------------------|-----------------------------------------------|--------------------------------------|
| Chhukha     | 25                                     | 4.94                                                        | 15                                            | 60.00                                |
| Dagana      | 54                                     | 10.67                                                       | 36                                            | 66.67                                |
| Others      | 31                                     | 6.12                                                        | 19                                            | 61.29                                |
| Mongar      | 13                                     | 2.57                                                        | 0                                             | 0.00                                 |
| Samdrupjongkhar | 89                                  | 17.59                                                       | 69                                            | 77.53                                |
| Samtse      | 84                                     | 16.60                                                       | 78                                            | 92.86                                |
| Sarpang     | 70                                     | 13.83                                                       | 59                                            | 84.29                                |
| Tsirang     | 140                                    | 27.67                                                       | 77                                            | 55.00                                |
| Total       | 506                                    | 100.00                                                      | 353                                           |                                      |

12 News articles in the mainstream media suggest that the growth in crop and livestock production is due to government support for boosting domestic production towards addressing shortages caused by import bans (Wangmo, 2020a, 2020b; Yonten, 2020)

13 The literal meaning of this Bhutanese term is “guardians of peace”. A De-Suup is a specially trained volunteer who provides voluntary services, especially during national emergencies (De-suup, 2021).
NR&DCA in 2018, 24 fish farmers from Samdrupjongkhar, Samtse and Tsirang were included in the sample while respondents from the remaining eight Dzongkhags were recruited randomly. Any recruited fish farmers who could not be contacted at the time of the survey were replaced with the farmer immediately next to them on the list in the NR&DCA’s fish farmer database. During the telephone surveys, farmers were addressed in their own spoken language. In total, 353 fish farmers were eventually surveyed, capturing 70% of the total Bhutanese fish farmer population of 506 in 2020. Fig. 1 shows a percentage breakdown of the total sample by Dzongkhag.

Development of the survey questionnaire was informed by a literature review and country experts at the NR&DCA, and the questionnaire was pre-tested on 10 fish farmers in four Dzongkhags: Dagana, Punakha, Sarpang and Zhampang. The three-part questionnaire collected information on how COVID-19-related policy measures have impacted Bhutanese fish farmers and how those farmers were adapting. Part A sought to establish whether the respondent was actively producing fish at the time of the survey. Part B asked how the measures have impacted access to fish production inputs, extension services and output markets and how fish farmers have responded. Finally, Part C explored how those policy measures have impacted fish farmers’ food security and what supports would help them to continue producing fish during the pandemic.

4. Results and discussion

4.1. Situational overview and overall impact

Of the 353 respondents, 280 (79%) had fish in their ponds at the time of the survey. The remaining 73 farmers had empty fishponds because they had ceased fish farming or had left their ponds temporarily unstocked for various reasons. In the latter group, 24 farmers (33%) had ceased fish farming because of chronic water supply problems, unfavourable religious sentiment, or pest/predator problems. A further 40 (55%) had left their fishponds temporarily unstocked because of water supply problems, pond maintenance and expansion work and/or pest and poaching problems. Only 9 (12%) farmers cited the pandemic restrictions as the main reason for leaving their ponds unstocked. However, among the 73 farmers with empty ponds, 20 (27%) reported experiencing the effects of the COVID-19-related policy measures on their fish farming activities, as they had emptied their fishponds and left it so only after the policy measures were implemented. Therefore, these 20 farmers along with the 280 who had fish in ponds make up the data on which the main results of this study are based. Overall, our findings suggest that COVID-19 restrictions have compounded the threat posed to the sustainability of the Bhutanese aquaculture sector by farmers discontinuing production (Dorji et al., 2022).

To assess the overall impact of pandemic-related policy measures on Bhutanese aquaculture, we asked 24 questions about their effect on access to production inputs, husbandry practices and output marketing. These questions capture the key activities of Bhutanese fish farmers; based on their answers, we identified 24 effect variables (Table 2). Overall impact was then estimated by plotting the number of farmers against the reported number of effect variables (Fig. 2). Our results indicate that most farmers have been impacted through multiple variables; for instance, 67 farmers (22%) reported the policy responses’ impact through four variables, and 278 farmers (93%) through at least three variables. At the extremes, while two farmers have remained completely unaffected, one has experienced effects through 13 variables.

Turning to exploring the effect on individual effect variables in greater depth, Fig. 3 shows that many respondents (53%) began to feel affected by the policy responses in August 2020, when the first national lockdown (NL1) was implemented. The next largest subgroup (13%) began to feel the effects when NL1 extended into September. The closure of the country’s international borders in March 2020 was identified by 7% of respondents as the point at which they began to feel impacted. For

| Table 2 |
| Effect variables for assessing the overall impact of COVID-19-related policy measures on Bhutanese aquaculture. |
| Variable | Definition of outcome for impact assessment |
| a) Input accessibility | |
| Fish seed for initial stocking | Impacted if has become difficult or impossible to obtain |
| Fish seed for subsequent stocking | Impacted if has become difficult or impossible to obtain |
| Fish farming equipment such as cast net | Impacted if has become difficult or impossible to obtain |
| Commercial feed | Impacted if has become difficult or impossible to obtain |
| Non-commercial feed | Impacted if has become difficult or impossible to obtain |
| Inorganic fertilizer | Impacted if has become difficult or impossible to obtain |
| Organic manure | Impacted if has become difficult or impossible to obtain |
| Paid labour | Impacted if has become difficult or impossible to obtain |
| Ice for fish storage | Impacted if has become difficult or impossible to obtain |
| Transport for fish farming activities | Impacted if has become difficult or impossible to obtain |
| Extension advice and services | Impacted if has become difficult or impossible to obtain |
| b) Husbandry practices | |
| Do initial stocking | Impacted if did earlier or later than usual time |
| Do subsequent stocking | Impacted if did earlier or later than usual time |
| Harvest fish | Impacted if harvested earlier or later than usual time |
| Cost of input transportation | Impacted if paid higher or lower than the usual cost |
| Amount of fish processed | Impacted if processed more or less than usual amount usually processed |
| Store fish unprocessed | Impacted if stored more or less than usual amount usually stored |
| Wage paid to hired labour | Impacted if paid higher or lower than the usual wage |
| c) Output marketing | |
| Selling fish at farmgate | Impacted if has become difficult or impossible to obtain |
| Selling fish at marketplace | Impacted if has become difficult or impossible to obtain |
| To take fish to marketplace | Impacted if has become difficult or impossible to obtain |
| Cost of transporting table fish to marketplace | Impacted if has paid higher or lower than the usual cost |
| Number of people visiting farm to buy fish | Impacted if has decreased or increased |
| Selling price of fish | Impacted if has sold at a higher or lower than usual price |
Fig. 2. Number of fish farmers reporting different numbers of effect variables pertaining to input accessibility, husbandry practices and output marketing through which they have experienced the impact of COVID-19-related policy responses.

Fig. 3. Perceived timing of the start of COVID-19's impact by Dzongkhags.
6% of the respondents, the effect was first felt in December 2020, when the second national lockdown (NL2) began. In general, the onset of felt effects across the major Dzongkhas mirrors the national scenario.

These findings are not unexpected. During NL1, mobility restrictions across Bhutan made it difficult or impossible for farmers to obtain inputs like fish seed or to perform essential activities such as feeding their fish (NR&DCA, 2021b). In these circumstances, the intensity of NL1’s impact was in part determined by the farmer’s geographic proximity to hatcheries. This explains why a greater proportion of farmers in Dagana than in Sarpang began to experience the effects of restrictions in August 2020, as those in Sarpang are closer to the NR&DCA and may have acquired fish seed prior to NL1. In contrast, most farmers in Dagana are further away from the NR&DCA and may have had to defer seed acquisition, which subsequently became difficult or impossible due to mobility restrictions.

4.2. Fish farmers’ responses to altered operating conditions

Bhutanese fish farmers have responded in diverse ways to the changes in the operating conditions caused by pandemic-related policy measures. Fig. 4 shows that about half of the respondents (49%) delayed initial stocking while 20% completed this task at the usual time. Most farmers (80%) reported no subsequent stocking while 14% completed this later than usual. As stocking typically begins in March/April, these delays may reflect voluntary delays in seed acquisition-related travel among farmers and extension agents. Rapidly spreading news of the pandemic elsewhere in the world and the first positive case in early March 2020 created a general sense of apprehension and uncertainty in Bhutan in early 2020 (NR&DCA, 2021b), which may in turn have delayed travel to acquire seed from hatcheries.

This explanation is consistent with the general tendency of farmers to be cautious and flexible regarding farming operations, so as to avoid the risk of undesirable outcomes under highly uncertain circumstances (Hardaker et al., 2015). In one empirical study, Kumaran et al. (2021) reported that awareness of the developing global pandemic had negatively influenced normal stocking behaviour among Indian shrimp farmers even before any lockdown in India. Similar modification of stocking behaviour was found among aquaculture producers in Bangladesh by Kabir et al. (2020) and Islam et al. (2021). In the case of Bhutan, delayed stocking may also reflect the loss of access to the efficient Indian route following the closure of the country’s international borders in March 2020. As the alternative domestic route makes seed transport more difficult, farmers in Samtse, Dagana and Chhukha were compelled to delay initial stocking. Mobility constraints associated with the NL1 also caused delays, especially for subsequent stocking, which is usually done between July and September (NR&DCA, 2021b).

Fig. 5 shows the timing of fish harvesting in relation to pandemic-related policy responses. While 40% of respondents have not harvested their fish since the onset of the pandemic, 20% harvested later than usual, and 12% harvested ahead of schedule. This variation may reflect changing demand for locally produced fish as a result of policy measures. For example, mobility restrictions may have prevented consumers’ regular fish-buying visits to local fish farms, reducing demand and prompting delayed harvesting. This effect has been reported in Bangladesh, where fish producers have also delayed harvesting to deal with pandemic-induced logistical disruptions and a fall in output prices (Hasan et al., 2021). On the other hand, some Bhutanese fish farmers may have been encouraged to harvest early following increases in the price of locally farmed fish (NR&DCA, 2021c) and the number of consumers visiting fish farms as a result of the ban on imported fish.

None of the respondents reported losses caused by discarded or spoiled fish, possibly because almost all (99%) said they had not
processed or stored any fish. This finding again confirms that most Bhutanese fish farmers are small-scale, subsistence-oriented producers who use non-purchased inputs and either consume their entire stock or hold on to the surplus without incurring any significant cost. A further reason for this ability to maintain unharvested stock is that Carp, the species farmed in Bhutan, can be sustained by non-purchased crude feed, forage and natural food (SPC Aquaculture, 2011), which may preclude the need to process or store stock. In line with this finding, none of these farmers reported borrowing money to cope with fish loss.

4.3. Impact on access to fish production inputs

The Bhutanese COVID-19-related policy responses have significantly impacted farmers’ access to fish production inputs. As shown in Fig. 6, 100 farmers (33%) reported difficulty obtaining seed for initial stocking. While 170 farmers (57%) said they did not practise subsequent stocking, 69 of those who did (53%) found it impossible to obtain seed for this purpose, and 25 (19%) reported difficulty in this regard. The difficulty of obtaining seed for initial stocking is probably a consequence of the loss of access to the Indian route due to the border closure in March 2020, which may have caused farmers in Samtse, Chhukha and Dagana to defer this task in the expectation that the Indian route would reopen when circumstances improved. However, as the borders have remained shut, farmers who wished to transport seed were compelled to use the more difficult domestic route.

The mass mortality of initial stocking seed suffered by many Samtse farmers while transporting seed along the domestic route lends support to this explanation (Gewog Extension Officer I, personal communication, 13 August 2021). Strangely, however, most farmers in Tsirang—which is immediately next to Sarpang, where the NR&DCA is located—also reported difficulty in obtaining seed for initial stocking.

One possible explanation is that these farmers were late in commencing initial stocking (as shown in Fig. 4) and may therefore have been impacted by NL1 mobility restrictions. Another possible explanation for the observed delay in initial stocking is that the partial lockdown in the adjacent Dzongkhag of Wangduephodrang in early March 2020 (Ministry of Health, 2021) meant that most farmers in Tsirang deferred initial stocking due to apprehension and were then constrained by NL1 mobility restrictions. In the case of subsequent stocking, logistical disruption associated with NL1 may have made it difficult or impossible to obtain the necessary seed. Again, physical proximity to a hatchery may have contributed to the severity of this effect as evidenced by the fact that most of those who were able to access seed for subsequent stocking were in Sarpang, where the NR&DCA is located, and Samdrupjongkhar, home of the RCA. Elsewhere too, for example, in Andaman and Nicobar islands of India (Kiruba-Sankar et al., 2022), fish farmers’ access to fish seed has been negatively impacted by COVID-19 countermeasures.

While 142 farmers (47%) made no attempt to acquire essential equipment such as cast net following the onset of the pandemic, 154 of those who did (51%) encountered difficulties in this regard. This is probably an effect of the disruption of cross-border trade caused by the closure of the country’s international borders; as Bhutan’s main source of fish production equipment is India, the border closure and ensuing trade restrictions make this more difficult to acquire. Similar effects have been reported among aquaculture producers elsewhere—for example, in the Mekong region (Lebel et al., 2021).

Access to fish feed has been differentially impacted by type. In the case of non-commercial feed, only 23 farmers (8%) reported any difficulty while most (90%) said that access was the same as usual. This is not unexpected, as most Bhutanese fish farmers rely on crude non-purchased feedstuff that is readily available on their own farms. In the case of

Fig. 5. Timing of table fish harvest by Dzongkhags.
commercial fish feed, 292 farmers (97%) did not use it, and 7 (2%) reported access difficulties. Access to fertilizers has been impacted in much the same way as feed; 293 farmers (98%) said that access to farm manure was as easy as before, and only two farmers reported any difficulty. In relation to inorganic fertilizers, 284 farmers (95%) said they did not use them, and 11 (4%) reported access difficulties.

Fig. 7 shows the impact of pandemic-related measures on the cost of transporting production inputs. While 138 farmers (46%) incurred no such costs since the pandemic struck, 141 (87%) of those who did said they incurred higher than usual costs. These increased costs are due to the increase in fuel prices caused by disruption in the supply chain with India, Bhutan’s source of fuels (Subba, 2021). Our finding aligns with Manlosa et al. (2021), who reported that the cost of transporting fish seed in the Philippines has increased as a result of COVID-19-related restrictions.

Our findings indicate that access to extension services such as logistical support and technical advice on production-related matters has been differentially impacted. While most respondents (61%) experienced difficulties in obtaining vital extension inputs, the remaining 39% reported access as usual. Among possible explanations, ease of acquisition of extension input may vary by type. For example, when mobility is restricted, a farmer may find it difficult or impossible to access extension support to transport fish seed from distant hatcheries, but production-related technical advice is readily available through phone communication with government extension professionals. In addition, the ability of government professionals in different Dzongkhags to provide aquaculture extension support may be variously constrained by differing responsibilities for local containment efforts. Our findings align with Alvi et al. (2021) account of how women farmers’ access to extension services in India and Nepal has been impacted by COVID-19-related restrictions.

4.4. Impact on post-harvest activities

Bhutan’s pandemic-related policy responses have also affected fish farmers’ post-harvest activities. While 56% of farmers reported that farm-gate sales of table fish had continued as usual, a small minority (2%) reported difficulties in this regard. The remaining 42% had not sold any fish since the pandemic began, and 97% said they had not sold in formal marketplaces while the remaining 3% reported doing so as usual.18 Taken together, these data suggest that Bhutanese fish farmers have benefited during the COVID-19 pandemic from their status as small-scale, subsistence-oriented producers, as few have experienced any difficulty in selling their produce for cash. In this regard, the ability to sustain stock with inexpensive non-purchased feed enabled Bhutanese fish farmers to delay harvest in response to any fall in demand, avoiding facing adverse economic outcomes like distress selling at reduced prices. Additionally, given the small surplus of coveted locally produced fish (Dorji et al., 2021) and the scarcity of imported fish in the formal marketplace as a result of import restrictions, the fish farmers have been able to sell their produce at least as easily as in pre-COVID-19 times. This reasoning is convincing when linked to our other finding that 31% of our respondents reported an increase in the number of buyers visiting their farms as opposed to the 15% who reported a decrease (see Fig. 8), which indicate that, overall, Bhutanese farmers have experienced an increase

18 It is common in Bhutan for people to visit fish farms and request farmers to sell them fish (Dorji et al., 2022).
in demand for their fish. Our findings align with Lebel et al. (2021), who found that commerce-oriented aquaculture farms in Thailand and Vietnam were more likely than subsistence-oriented farms to be negatively affected by COVID-19-induced output demand shocks.

Fig. 9 shows how the price of fish has changed in response to the stimuli provided by COVID-19-policy measures. While 41% of our respondents had not sold any fish since the pandemic began, 83% of those who made sales achieved higher prices than usual. This finding clearly reinforces our finding that locally produced fish is a sought-after commodity in Bhutan. Cross-border trade disruption due to border closure and the ban on meat imports have made locally produced fish scarcer and more valuable (although the increase in price due to such a supply shock may be temporal). In this regard, the NR&DCA has also reported that the average pre-pandemic price of locally farmed fish in Bhutan has since increased by 67% (NR&DCA, 2021c). This finding contrasts sharply with other evidence that pandemic-related restrictions have generally caused the prices of aquaculture products to fall (Azra et al., 2021; Hasan et al., 2021; Kumaran et al., 2021).

Only four farmers reported incurring a cost to transport table fish to market, and eight said they have used ICT to sell fish. These statistics suggest that, unlike aquaculture producers elsewhere (Belton et al., 2021; Manlosa et al., 2021; Senten et al., 2021), Bhutanese fish farmers have not suffered difficulties in disposing of harvestable fish, mainly because of their subsistence-orientation and the ability to sustain the stock on non-purchased inputs. In line with the reported increase in the number of people visiting farms to buy fish, most Bhutanese fish farmers with surplus stock have probably been able to sell at the farm gate without incurring output-related transaction costs.

4.5. Desired critical supports

In light of resource limitations, support provisions must be prioritized to address key constraints to aquaculture production. To that end, fish farmers were asked to report the types of government support that they desired under three categories: most important support, second most important support and third most important support. The reported support types under each category were analysed for criticalness using the method proposed by Wilkinson (2006), and the results are reported.

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19 The remaining farmers reported either that the number of buyers visiting them has remained unchanged or that nobody had visited them to buy fish since the onset of the pandemic. Having no visit by a buyer should not be interpreted as farmers facing problems of selling fish, because every such visit does not necessarily translate into a sale as it is normal behaviour for the average Bhutanese farmer to choose not to sell, preferring to self-consume their entire stock at home (Livestock Production Officer at NR&DCA, personal communication, 4 July 2022). As such, a farmer is considered affected by the pandemic in terms of demand for fish if it is reported that the number of people visiting to buy fish has either increased or decreased (as defined in Table 2).

20 Not having sold any fish since the start of COVID-19 cannot be interpreted as a decrease in demand or farmers facing difficulty to sell fish. This is because it is common for Bhutanese farmers to choose not to sell, preferring to self-consume their entire stock at home, mainly because they operate small back-yard ponds and hence have little or no surplus to sell (Livestock Production Officer at NR&DCA, personal communication, 4 July 2022). Potentially attesting to this point, Dorji et al. (2022) reported that the median pond size, fish output and household size in a nationally representative survey of Bhutanese fish farmers were 170.5 m², 45 kg and 6 people, respectively.
The 95% acceptance intervals for frequencies of support types reported in the table are of a reference distribution in which all support types are assumed to be desired equally. On that basis, any support type with an observed frequency exceeding the upper bound of their reference 95% acceptance interval is deemed critical—that is, it is more desired than those with frequencies within the interval or below its lower bounds.

Table 3 indicates that Bhutanese fish farmers consider it critical that the government provides support for three activities: (i) acquiring fingerlings and feed; (ii) excavating new fishponds and expanding or renovating old ones; and (iii) maintaining continuity of water supply for fishponds. These requirements are not a novel consequence of pandemic-related policy measures but reflect chronic challenges that have been hampering Bhutan’s aquaculture sector. This conjecture is supported by the finding that, among the farmers with empty fishponds, 33% had permanently ceased fish production because of water supply problems and other reasons while 55% had temporarily ceased production because of water supply and pond maintenance problems. Our appraisal is further reinforced by the fact that Bhutan has only two hatcheries to supply farmers across the country and that most farmers use either the difficult domestic route or the unpredictable Indian route to transport fish seed. In any case, our findings echo the proposed supports for aquaculture producers in other countries; in Bangladesh, for example, it is proposed to reduce the cost of fish seed and feed and relax transport restrictions to sustain small-scale aquaculture production (Islam et al., 2021). However, unlike aquaculture producers in countries like Malaysia and China, that have stressed the need for produce marketing support (Azra et al., 2021; Zhang et al., 2021), Bhutanese fish farmers are mainly concerned about production-related issues.

### 4.6. Food security during the COVID-19 pandemic

To assess whether COVID-19-related policy responses have impacted the food security of fish farmers, we asked them how difficult it has become to consume and buy key and secondary food items during the ongoing pandemic. Consumption of key and secondary foods has been differentially affected; while a sizeable majority (89%) have not experienced any difficulty in consuming their key foods, 11% reported difficulty in this regard. In sharp contrast, 202 farmers (67%) reported difficulty related to consumption of secondary foods as against 98 (33%) who reported consuming them as usual. In terms of purchasing ability, most farmers have experienced negative impacts, as 282 (94%) reported difficulty in buying key foods, and 213 (71%) reported difficulty in buying secondary foods.

Our findings have a few important implications. First, as subsistence-oriented integrated farmers who produce a range of other agricultural commodities along with fish, Bhutanese fish farmers’ food security has been minimally affected by the scarcity of main foods like chillies, onions and tomatoes. This aligns with findings from India, where farmers in Odisha state have been less impacted by pandemic-induced food supply disruptions than farmers in Haryana state, mainly because of the prevalence of crop diversification and homestead gardening in Odisha (Ceballos et al., 2020). The Bhutanese government’s doorstep delivery

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21 As none of the support type in the third most important category exceeded the upper limit of their reference 95% acceptance interval, the result of analysing this support category is not reported here.

22 For details on how the intervals are computed and what they imply, see Wilkinson (2006).

23 The routes through India become unavailable when there are events such as strikes in the states they pass through.
programme for essential food items has also helped to maintain the fish farmers’ ability to consume them.

Second, in terms of the ability to buy, Bhutanese fish farmers (much like other population groups in Bhutan) have experienced major disruption of key and secondary food supplies (Wangmo, 2021). This owes mainly to pandemic-related cross-border trade restrictions and bans on the import of key food items (Wangmo, 2020b), as Bhutan is a net importer of key foods. In 2019, for example, Bhutan imported 7240 metric tonnes of fresh meat, 16,094 metric tonnes of fresh vegetables and 3001 metric tonnes of fresh fruits from India alone (RNR Statistics Division, 2020). Our findings confirm that the accessibility dimension of food security has been more severely impacted by pandemic-induced worldwide disruptions (Bené et al., 2021). Overall, however, COVID-19-countermeasures have not drastically affected food security among Bhutanese fish farmers, and the majority are able to consume their key foods as usual.

5. Conclusion and policy recommendations

COVID-19 and associated policy responses have exacerbated global food and nutrition insecurity by disrupting supply chains, lowering incomes and increasing food prices. The effect on poorer people has been especially severe for various reasons, including an inability to earn from physical labour. As a result, some have resorted to harmful coping strategies that include depleting assets. In aquaculture supply chains, vulnerable actors like small-scale producers have been adversely impacted in several ways by pandemic-related policy responses. For the purposes of this study, we used data from a phone survey in Bhutan to capture how these policy responses have impacted the ability to produce and sell fish and aquaculture farmers’ food security.

Despite disruptions caused by input accessibility impairment, Bhutanese fish farmers have not suffered the disastrous economic outcomes of supply chain disruptions that affect their large scale, commercial counterparts elsewhere. Furthermore, the COVID-19 pandemic has revealed an opportunity for the Bhutanese fish farmers to gain substantial economic benefits by boosting production to capitalize on the current scarcity of fish in the domestic market. Indeed, these farmers have gained from an acute shortage of imported fish, which has increased demand and market value of locally farmed fish. The fish farmers have adapted to altered operating conditions by modifying husbandry practices and increasing their output prices.

Our analysis also reveals that despite some disruption in terms of food accessibility, Bhutanese fish farmers’ food security has not suffered drastically overall, probably because they are subsistence-oriented, self-sufficient integrated producers and/or because of the government’s food security programme. However, it has become apparent that being import-dependent for key food commodities worsens Bhutan’s overall vulnerability to global COVID-19-like shocks and that its robustness would improve through enhanced food self-sufficiency.

Overall, Bhutanese fish farmers have proved to be robust to COVID-19-induced adverse outcomes relative to commercial aquaculture producers elsewhere: small-scale, subsistence-oriented production of fish along with other crops has benefitted these farmers by shielding them from the negative economic outcomes associated with market shocks and by directly preserving their food security. Nevertheless, Bhutanese fish farmers will need government support to overcome key challenges, so that they can sustain and bolster fish production during the ongoing pandemic and become more robust to future COVID-19-like shocks. Based on our findings, we recommend the following short-and-long-run policy measures:

Short-run measures:

i. Educate fish farmers about the availability of government logistical support for accessing fish seed from hatcheries.
Table 3
Critical government support required by Bhutanese fish farmers to sustain and boost fish production during and after the COVID-19 pandemic.

| Desired support | Observed frequency | 95% Acceptance interval for reference distribution | Percentage contribution to total support types | Rank |
|-----------------|--------------------|-----------------------------------------------|-----------------------------------------------|------|
|                 | Lower bound | Upper bound |                                |                        |      |
| a) Most important support |          |          |                                |                        |      |
| Feed            | 118       |           | 29 39 42.91 1**                |                        |      |
| Fingerlings     | 69        |           | 27 34 25.09 2**                |                        |      |
| Excavate/Expand/Maintain pond | 40 |           | 26 32 14.55 3**                |                        |      |
| Improve water supply | 29       |           | 25 30 10.55 4*                |                        |      |
| Improve farm security | 7         |           | 24 28 2.55 5                |                        |      |
| Fish marketing  | 3         |           | 23 27 1.09 6                |                        |      |
| Equipment       | 3         |           | 21 26 1.09 7                |                        |      |
| Training        | 2         |           | 20 25 0.73 8                |                        |      |
| Reliable extension services | 2 |           | 18 24 0.73 9                |                        |      |
| Transportation  | 1         |           | 16 23 0.36 10               |                        |      |
| Others          | 1         |           | 13 21 0.36 11               |                        |      |
| b) Second most important support |          |          |                                |                        |      |
| Fingerlings     | 68        |           | 22 31 36.76 1**              |                        |      |
| Feed            | 38        |           | 20 26 20.54 2**              |                        |      |
| Improve water supply | 23       |           | 19 24 12.43 3*              |                        |      |
| Excavate/Expand/Maintain pond | 15 |           | 18 22 8.11 4                |                        |      |
| Transportation  | 13        |           | 17 21 7.03 5                |                        |      |
| Others          | 9         |           | 16 20 4.86 6                |                        |      |
| Fish marketing  | 9         |           | 15 19 4.86 7                |                        |      |
| Training        | 5         |           | 13 18 2.70 8                |                        |      |
| Equipment       | 4         |           | 11 17 2.16 9                |                        |      |
| Reliable extension services | 1 |           | 8 15 0.54 10                |                        |      |

Note: This table reports the results of the analysis of reported desired support as per the method proposed by Wilkinson (2006). Total observed frequencies are 275 and 185 for the most important and second most important support categories, respectively. For any support type, if its observed frequency exceeds the upper bound of the 95% acceptance interval for the reference distribution, it is a critical support. In line with this, ** indicates a critical support type and * indicates a marginally critical support type. For technical details of the analysis, see Wilkinson (2006).

To improve our understanding of how COVID-19-related policy responses impact low-income, vulnerable aquaculture producers, future research should focus on investigating how aquaculture extension service delivery has been impacted. Future studies should also seek to identify the critical factors that determine small-scale aquaculture producers’ ability to adapt to catastrophic scenarios like COVID-19, as well as assessing how the pandemic has impacted other dimensions of food security and wellbeing among vulnerable aquaculture producers.

CRediT authorship contribution statement

Namgay Dorji: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Data curation, Funding acquisition, Project administration. Satoshi Yamazaki: Supervision, Conceptualization, Methodology, Investigation, Formal analysis, Validation, Resources, Writing – review & editing, Funding acquisition, Project administration. Pema Thinley: Investigation, Writing – review & editing, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Research data cannot be shared due to privacy and ethical reasons.

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Appendix A. Timelines of major Bhutanese COVID-19 countermeasures and fish production activities
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### 2020

| Date       | Event Description                                      |
|------------|--------------------------------------------------------|
| March 6    | First COVID-19 case confirmed                         |
| August-September 2020 | First nationwide lockdown                                   |
| December 2020—February 2021 | Second nationwide lockdown                                   |

### 2021

| Date       | Event Description                                      |
|------------|--------------------------------------------------------|
| March 23   | International borders closed.                          |
| March 27   | COVID-19 vaccination begins                            |

### One fish production season (March/May ~ January/March)

- **Initial stocking period (March ~ May)**
- **Subsequent stocking period (July ~ September)**
- **Fish harvest period (December ~ March)**
