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Assessing the impacts of COVID-19 on the aquaculture industry in South Africa, using the marine mussel farming sector as a case study

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Abstract. This study investigated the impacts of COVID-19 on the aquaculture sector in South Africa. The study was conducted on the West Coast of the Western Cape, South Africa. A multiple-case study approach was followed, focusing on the marine mussel farming sub-sector in Saldanha Bay. Semi-structured interviews were conducted with the owners or managers of nine mussel farming enterprises, and with nine representatives of role players with responsibility or experience in aquaculture, agriculture, or enterprise development. The results of the study focussed on the impacts of COVID-19 on the aquaculture sector and role player organizations; COVID-19 support; initiatives for preparation, survival, and rebuilding; factors promoting resilience, survival, and rebuilding; and requirements to survive and rebuild the sector. The main impact on the aquaculture sector was the closure of markets, which led to cascading impacts on all aspects of the value chain. Role players were affected through impacts on programmes, projects, and staff. Various COVID-19 relief schemes were made available however these could not address all the needs of the sector. Enterprises prepare for the pandemic and the future through long term planning. The main factors contributing to resilience were subsidisation from shareholders, having reserve funds and multiple streams of revenue. The most critical requirements to survive and rebuild the sector was financial support and the opening of markets. The study recommends follow up assessments of the aquaculture industry to fully understand and quantify the effects of the prolonged pandemic and provide tailor-made solutions for each sub-sector to stabilise, revive and grow the aquaculture sector in the medium to long term. Aquaculture enterprises that have closed or are at risk of closure should be prioritised first before any investment in new ventures is considered. In addition, the development of an aquaculture industry-based Business Continuity Strategy and the Ocean Economy Master plan should be prioritised to assist enterprises until the pandemic is over, to prepare for normalisation of operations thereafter, and to prepare the sector and individual enterprises to be more resilient in case of future global crises and disasters.

Keywords. Aquaculture, COVID-19, bivalve shellfish, mussel, resilience

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1. Introduction

The coronavirus disease 2019 (COVID-19) is a global pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease was identified for the first time in China in December 2019 and thereafter spread rapidly throughout the world. COVID-19 was declared a pandemic in March 2020.

Due to the absence of a vaccine at the time and the potential of the virus to cause massive mortalities, the World Health Organisation recommended a Global Strategy for the disease, which included physical distancing and restrictions on travel (WHO, 2020). Countries responded with measures aligned to this Strategy, which caused a drastic reduction in travel, freight movement and individual freedom of movement, and had a devastating effect on economies worldwide.

The South African government responded by declaring the State of Disaster on 15 March 2020, and measures that curbed social and economic activities, including travel restrictions and five levels of lockdowns. The country went into full lockdown (Alert Level 5) on 26 March for 35 days. Thereafter restrictions were progressively eased to Alert Level 1 by 21 September 2020. These measures caused varying levels of devastation in different economic sectors, affecting all provinces. In response, the South African government put together a 3-phase, 18-month approach to economic interventions aimed at preserving the economy, recovery from the immediate effects of the crisis and building a stronger economy post-COVID-19.

This included an R500 billion financial support package and monetary financial regulatory policies such as reduction of interest rates, to the value of R300 billion (National Treasury, 2020). One of the policies developed included a Corona Virus Temporary Employer-Employee Relief Scheme (COVID19TERS) administered through the Unemployment Insurance Fund (UIF), (Department of Labour, 2020). In response to the pandemic, Statistics South Africa conducted three experimental surveys aimed at providing early indicators on the impact of the pandemic on South African businesses, spanning the period between 30 March and 20 May 2020. The first two surveys covered the period during Lockdown Level 5, and the third was done after restrictions had been eased to Level 4. All three surveys indicated negative impacts on turnover, trading activity, workforce, input prices and financial assistance. The second survey indicated that 8.6% of respondents had permanently ceased trading, and the third survey indicated that 55% of respondents could survive between one and three months without any turnover. Although these surveys provided near-real-time early indicators, measurement of the actual impact of the pandemic is dependent on the identification of critical variables including the duration of the pandemic, and its intensity in terms of infection rates (Stats SA, 2020c, 2020a, 2020b).

During the five years before the COVID-19 pandemic, the South African government and private sector invested more than R1.2 billion into the aquaculture sector, through interventions such as Operation Phakisa: Ocean's Economy (Aquaculture workstream). This included investment into 35 catalytic projects, 28 of which were Small, Medium, and Micro-sized Enterprises (SMMEs). Twelve of these were new or expansion of existing bivalve shellfish (mussel and oyster) production enterprises in Saldanha Bay (DAFF, 2018). Aquaculture production (freshwater and marine) was 6366 tons in 2018, valued at R1.12 billion (DEFF, 2021).

The South African aquaculture sector was regarded as an essential industry sector under COVID-19 restrictions and allowed to continue operations. However, due to disruptions in other industry sectors such as the travel and tourism industry, the markets for aquaculture products

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were affected. The Department of Forestry, Fishing and the Environment surveyed the aquaculture industry shortly after the start of the pandemic, in April 2020. At that stage, respondents reported an average 54% loss in sales compared to the previous year. Total anticipated loss in sales/income up to October 2020 was estimated at R402 billion (representing 39% of entire sector sales), with an anticipated impact on more than 1200 jobs.

The survey indicated that without cash reserves, an estimated 70% of aquaculture farms were at high risk of closure. The most common support required was soft loans and other finance (R137.2 million), deferred finance (R9.1 million) and feed support. Several short-term (0-6 months) and medium-term (6 months+) support interventions were proposed to support farms in distress. (DEFF, 2020). This survey formed the basis of a COVID-19 response plan, to be incorporated into the responsible department's annual performance plan. The main purpose of this paper was to understand the impacts of the COVID-19 pandemic on aquaculture enterprises in South Africa after April 2020, what is needed to recover from these impacts and how this understanding could be incorporated into a model for the development of self-sustainable aquaculture enterprises in South Africa.

2. Methodology

This study was included in a wider research project investigating self-sustainability in aquaculture enterprises in South Africa. The marine mussel farming industry was used as a case study, as it is the largest contributor to aquaculture production in South Africa (DAFF, 2017). The study was mainly based on semi-structured interviews with marine mussel producers in the bivalve shellfish (mussel and oyster) sector, and role players in the aquaculture and enterprise development sectors. Interviews were conducted between 19 March (just before the country went into full lockdown Level 5) and 12 October 2020, when restrictions had been eased to Lockdown Level 1. Therefore, responses reflected an evolving situation over various levels of lockdown and restrictions. This should be considered in the analysis and interpretation of results.

2.1. Study area

The study focused on marine mussel producers in South Africa's bivalve shellfish (mussel and oyster) aquaculture industry. The study area was Saldanha Bay, on the West Coast of South Africa, and included three bivalve shellfish farming areas totalling 460 ha. The survey population included 27 bivalve shellfish farming enterprises in the study area that were approached through the Bivalve Shellfish Farmers Association of South Africa and the Western Cape Provincial Department of Agriculture. The sample size for this study included nine of the existing enterprises listing mussel cultivation as a primary or secondary activity. The selection was mainly based on willingness to be involved in the study.

The mix of enterprises included established commercially focused and empowerment enterprises, and new or emerging, commercially focused enterprises. The survey population also included role players in South Africa with responsibility or experience in aquaculture, agriculture, or enterprise development. The selection was based on willingness to be involved in the study, and availability. The role player categories included two national and provincial government departments with responsibility for aquaculture, three aquaculture associations, two universities and two individuals with experience or expertise in aquaculture farming and enterprise development. These role players were, therefore, able to provide insights on aquaculture and enterprise development from Southern African, government, industry, research, education, and practitioner perspectives.

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Table 1: Role player categories with their associated spheres of influence

Role Player Category	Sphere of influence or representation	Number of persons interviewed
National and provincial Government departments with responsibility for aquaculture or agriculture	1. National aquaculture sector (freshwater and marine) 2. Western Cape provincial aquaculture sector (freshwater and marine)	2
Aquaculture associations	1. Aquaculture stakeholders in Southern Africa 2. Seven freshwater and marine aquaculture producer associations in South Africa 3. All bivalve shellfish producers in South Africa	3
Universities	1. Agricultural Sciences including Aquaculture research, training, and development; Commercial aquaculture development expertise 2. Social dimensions of the fishing, aquaculture, and coastal sectors	2
Individual - Experienced aquaculture farmer and mentor	South African commercial aquaculture and development expert with practical experience in mentoring of emerging aquaculture farmers	1
Individual - Enterprise development expert	Expert in enterprise development, technology transfer, business incubation and strategy/programme design and implementation in South Africa	1
Total		**9**

2.2. Data collection

An empirical, phenomenological approach was followed, as described in the literature (Remenyi *et al.*, 2010). A case study approach was selected as a suitable method, as it is a scientific research method in its own right and can generate context-dependent knowledge as described by several researchers (Flyvbjerg, 2006; Yin, 2009; Remenyi *et al.*, 2010). Semi-structured interviews were conducted with the owners or managers of bivalve shellfish farming enterprises selected as case studies, and with the representatives of role, players selected.

A qualitative approach was followed to conduct the research. Due to the implementation of COVID-19 restrictions on movement during the time the study was conducted, interviews mostly took place via video-conferencing or cellular phone platforms. Interview questions were structured around the themes of the impact of COVID-19 on the aquaculture sector, support received, mechanisms for coping, factors contributing to resilience and requirements to survive

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the pandemic. This information was communicated before interviews as part of the Participant Consent forms.

2.3. Sampling procedure

The sample size included nine bivalve shellfish aquaculture enterprises that were in operation before the onset of the pandemic. The selection was mainly based on willingness to be involved in the study. The mix of enterprises included commercially focused empowerment, and new or emerging, commercially focused enterprises. The role player sample included two representatives from national and provincial government departments with responsibility for aquaculture, three aquaculture associations, two universities and two individuals with experience or expertise in aquaculture farming and enterprise development. The selection was based on willingness to be involved in the study, and availability. Nine role player interviews were conducted.

2.4. Data analysis

Multiple-case study analysis consisted of two stages. Firstly, within-case analysis was conducted, where the qualitative data were analysed by identifying and copying responses from each transcription that were relevant to each of the questions asked during the interview. These responses were further analysed to create themes and sub-themes (or codes). MS Excel was used for the second stage of analysis (cross-case analysis) where a grouping of themes and sub-themes as well as summarising of codes was completed.

3. Results and Discussions

South African aquaculture products are marketed locally and internationally, depending on the species. Most of the new entrants sell to local retailers, and more advanced businesses use distributing agents, marketing companies or in-house marketing experts. Some producers sell to processing plants that sell processed products in the local or international market. Primary processors have developed their cold storage and distribution networks, and there are also fully integrated marketing and merchandising operations responsible for distribution to the retail sector.

In 2018, total aquaculture production was 6366 tons, valued at R1.1 billion. About 3191 tons (mostly tilapia) were exported, with an estimated value of R199.3 million. The remainder was sold locally. Most farmed mussels (2182 tons in 2018) were sold locally. The mussel export market was estimated at 66 tons valued at R2.8 million (DAFF, 2017; DEFF, 2021). It is therefore not surprising that the aquaculture sector was severely impacted through the COVID19 lockdown closures of both at local and international markets, as it had ripple effects throughout the value chains for all species (freshwater and marine). To understand the impacts of the global COVID-19 pandemic on aquaculture enterprises in South Africa, and what is needed to recover from these impacts, the researcher solicited opinions and insights from the enterprise case study and role player respondents about the effects of COVID-19 on their businesses or organisations; COVID-19 support provided or received; initiatives to prepare, survive and rebuild; factors promoting resilience, survival and rebuilding; and requirements to survive and rebuild businesses. The responses of enterprise case study respondents reflect the experiences of owners or managers in the bivalve shellfish value chain, whereas role player responses reflect a broader, industry-wide perspective. This must be kept in mind when analysing the results, as the two groups had different perspectives on the same subjects.

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The responses from enterprise case study informants were grouped into five main themes including the impact on operations and production, COVID-19 and other support, initiatives to prepare, survive and rebuild, factors promoting resilience, survival and rebuilding, and requirements to survive and rebuild the business. These themes are presented in Figure 1.

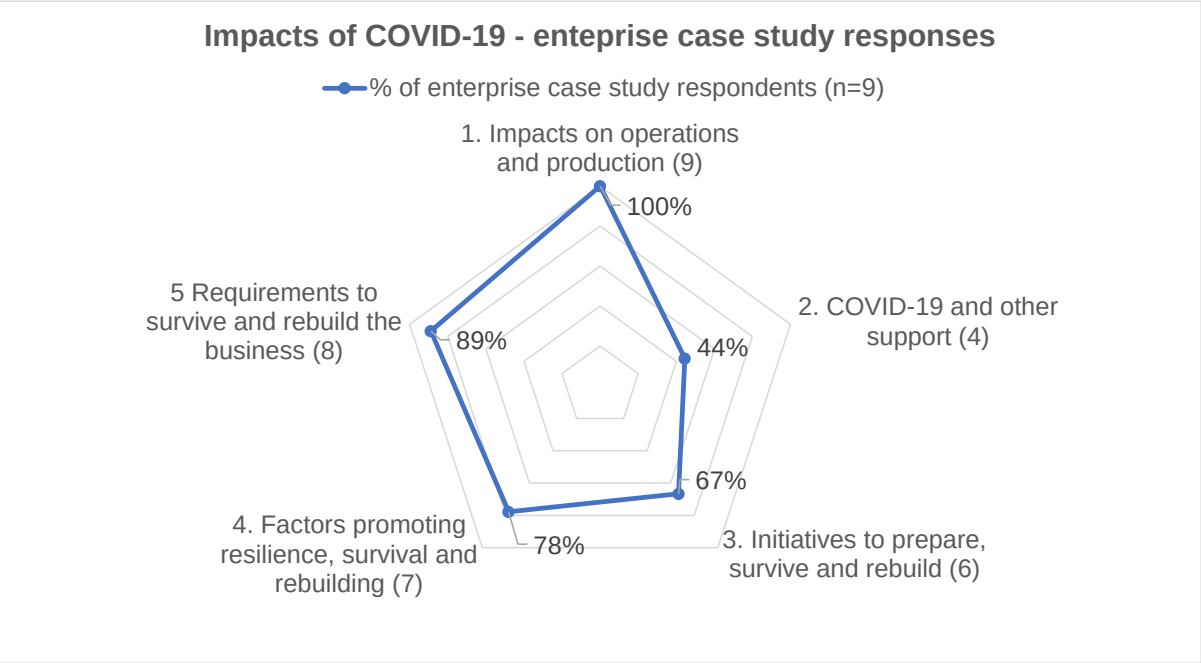

Figure 1: Enterprise case study respondents on COVID-19 areas of impact

As illustrated in Figure 2, the responses from role player informants were grouped into five main themes including the impacts of COVID-19 on their organisation; impacts on the aquaculture sector; COVID-19 support; factors promoting resilience, survival, and rebuilding; and requirements to survive and rebuild. They offered perspectives and insights for the wider aquaculture and agribusiness sectors.

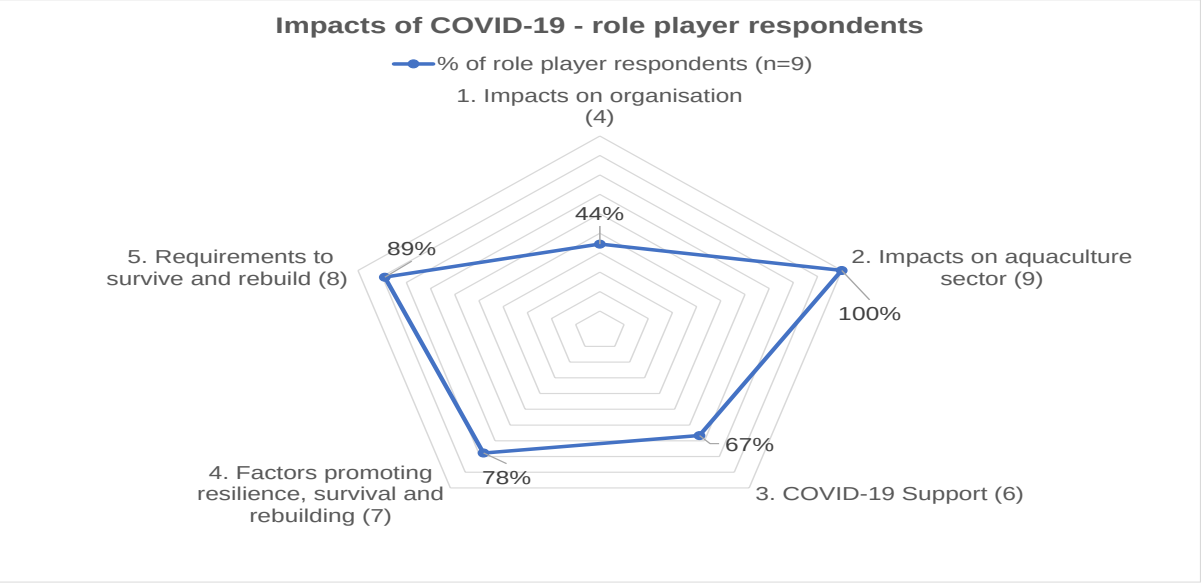

Figure 2: Role player respondents on COVID-19 areas of impact

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3.1. Impacts on aquaculture operations

Responses from enterprise case study informants are summarised in Figure 3. The main impacts were temporary closures (33%), closure of markets (89%), reduced harvest and excess product (44%), no or delayed production (44%), impact on employment and staff (67% and inability to pay costs (33%). Aquaculture was regarded as an essential service and therefore could continue during the lockdown. However, at the start of Alert Level 5, some enterprises closed to get the correct COVID-19 procedures in place. Many enterprises already had plans in place for quieter production periods (especially due to red tide). The effects of temporary closures varied between companies. Whilst some enterprises shut down for the first few weeks of lockdown for reasons varying from preparation of COVID-19 management plans to red tide, others reported periodic closures tied to the continuous risks of infection amongst staff.

The biggest effect of COVID-19 on the bivalve shellfish sector was the closure of markets and a drop in sales. This was because most bivalve shellfish products are sold into the local hotel, restaurant, and catering (HoReCa) industry, which was severely affected by the restrictions on movement. Exports were halted because of the restrictions on travel and freight and became very expensive when shipping and flights resumed. Oyster producers were especially hard hit as oysters were regarded as a ‘luxury’ product, sold life, and typically consumed with alcohol. Alcohol sales were banned or restricted, and the HoReCa industry operations were curtailed under most Alert Levels. The closure of markets and reduced income resulted in reduced or delayed production activities, reduction in harvests and an excess of product. Two respondents mentioned that some producers harvested and processed their raw material, which had to be stored until markets opened.

Besides increased storage costs, this led to concerns about overproduction and potential price wars in an already saturated market. Reduced operations also led to the loss of or unmarketable raw material, as the animals continued growing. One producer estimated a loss of at least 160 t of raw material for the year. The impact on production also meant that new, emerging farmers were delayed in starting their production or fell behind with their planned production schedules. Although 67% of respondents reported that employment and staff were affected, the specific impacts varied. One producer reported dismissals because of non-adherence to company COVID-19 rules, and an expected 10% reduction in staff numbers as a result. Others reported negative effects on staff morale, especially due to job uncertainty. In some cases where companies were unable to pay salaries, staff were able to access the COVID19TERS benefits through the UIF for a few months. Unfortunately, some staff misinterpreted the benefit as an additional payment on top of their normal salaries, which affected relationships between staff and managers.

The loss of income meant that some producers were unable to pay normal operational costs such as maintenance or lease fees. One company simply used the lease money to pay more urgent operational costs, whilst another tried to negotiate with Transnet National Ports Authority (TPNA) for suspension or reduction of water lease fees.

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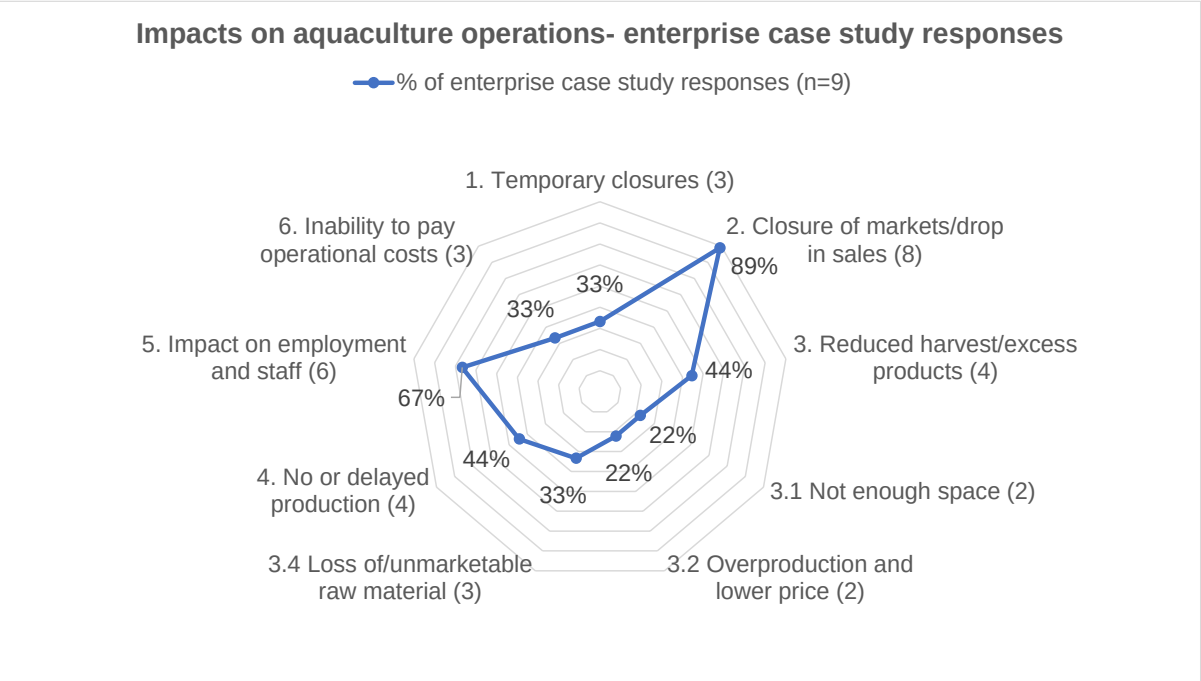

Figure 3: Enterprise respondents on COVID-19 impacts on aquaculture operations

Role players identified the main impacts as reduced operations (33%), loss of production (33%), overstock (56%), lower prices (44%), market closures (89%), financial difficulties (67%), cost-cutting (67%), the opportunity for mergers (11%), improved communication (11%) and reduced investment (11%). The main impact was the closure of markets and loss of sales and income. Sub-sectors such as mussels and oysters were especially hard hit because most of their local sales went into the HoReCa industry, which was shut down for long periods. Those with access to processors could harvest, process and store products however, they did not have unlimited storage facilities.

Access to export markets (e.g., in China) was also curtailed due to freight and logistical challenges. The abalone export market to China had collapsed before 2019 due to political issues, and COVID-19 added further pressures to this industry sector. One respondent estimated that producers were selling only 30% of what they were able to sell in 2019. The overstock of products affected the whole value chain with hatcheries and nurseries unable to move stock, and producers unable to harvest. In the mussel sector, this led to shake-offs, which also led to mussels lying on the bottom sediments with potentially negative effects. The lack of harvesting also meant a loss of production, which one respondent estimated would amount to about 500 t for the year. Because animals keep growing, in many sectors the closure of markets meant that aquaculture products grew outside the traditional size brackets preferred by specific markets. For example, bigger and older mussels were less desirable and fetched lower prices. In the trout industry, farmers culled fish and sold them into the cat food market as it was too expensive to keep feeding them. Because of stockpiling, there were fears of oversupply and lower prices when markets did open.

Knock-on effects of market closures were financial difficulties and potential business closures, cutting costs such as energy and labour, and overstock across the value chain. One respondent estimated that most of the bivalve shellfish producers only had cash reserves for two

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months, after which they would need business rescue or close their businesses. They estimated that at least 20% of these businesses may need to close.

The bigger companies with processors could sell processed and frozen products into the retail sector however most of the smaller companies sold directly to the food services sector. It was specifically mentioned that some of the companies selling fresh mussels were already going out of business, and some abalone farms were experiencing financial difficulties. Whilst businesses received little or no income, they still had to pay operating costs such as feed, energy, and labour. Whilst a survey at the initial stages of the pandemic indicated minimal staff reductions, there was recognition that further surveys at a later stage may reveal a different picture. Some respondents did indicate that aquaculture had "gone into survival mode", and some companies coped through retrenchments, sending staff home without pay, working with 10% skeleton staff, temporary business closures, and reductions in remuneration packages. Staff, infections also meant that people had to self-isolate for 14 days, which affected productivity. One respondent estimated a 10% reduction in total employment in the aquaculture sector for the year. One respondent mentioned that there was a reduced investment in new sectors such as marine finfish and tilapia, as investors such as big corporates with cash reserves stopped investing in innovation and development. Some respondents identified positive effects such as the opportunity for mergers or joint ventures, and improved communication between government and industry.

The results of this study echo the findings of studies worldwide regarding the impacts of COVID-19 on the aquaculture sector in general (marine and freshwater), specific sub-sectors/species, and fisheries. The biggest impact on aquaculture enterprises, production and operations were the closure of markets and disruptions of travel and freight, leading to disruption of traditional marketing channels and supply chains. This, in turn, caused loss of turnover; financial losses; problems with obtaining input supplies; overstock of animals and low prices due to low demand and oversupply; disruption of production schedules and loss of raw material; and loss of employment and income for workers (Jamwal and Phulia, 2021; Kumaran *et al.*, 2021; Lebel *et al.*, 2021; Manlosa, Hornidge and Schlüter, 2021; van Senten, Engle and Smith, 2021). In India, the pandemic caused an estimated economic loss of USD1.5 billion in the shrimp farming sector alone (Kumaran *et al.*, 2021).

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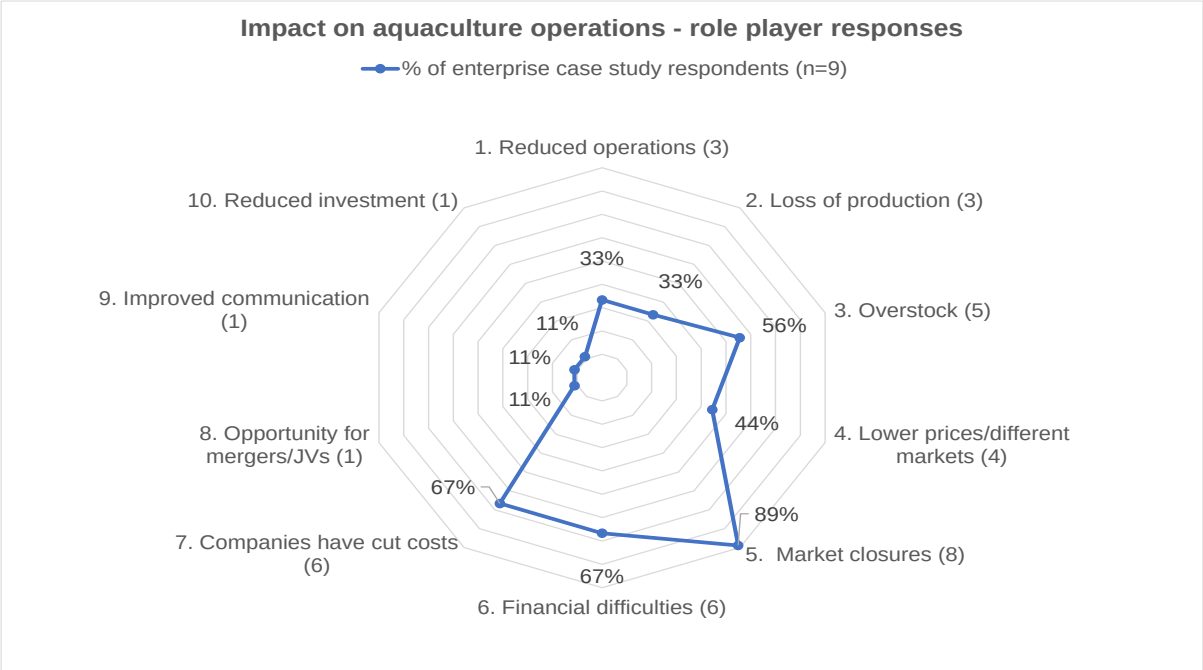

Figure 4: Role player responses on COVID-19 impacts on aquaculture operations –

3.2. Impacts on role player organisations

Role player organisations experienced negative impacts related to their projects and programmes (44%), staff (33%) and restriction of movement (22%), as summarised in Table 2. Whilst one respondent stated that support programmes are being implemented, as usual, others reported negative impacts on programmes such as small-scale producer support, enterprise and supplier development, and bankruptcy of an association. The pandemic showed weaknesses in systems, such as internet communication, the flow of information and the completion of administrative tasks. Staff had to start working remotely, on a rotational basis and cancel site meetings to projects. Some respondents reported negative staff morale and elevated levels of anxiety due to infections, self-isolation, and reductions in salaries and benefits such as pension and leave allocations.

Table 1: Thematic impacts on organisations of role players and their associated percentages

Themes	Number of role players responded (n=9)	Percentage (%) of respondents
1. Impacts on projects and programmes	4	44%
2. Restriction of movement	2	22%
3. Impacts on staff	3	33%

3.3. COVID-19 support

As indicated in Table 3, four enterprise case study respondents (44%) and six role player respondents (667%) commented about COVID-19 related support. Only one enterprise case study respondent reported that they received no support and that it was difficult to get through to government employees. Two were able to access the COVID19TERS benefit through the UIF scheme, which assisted with the payment of workers for a few months. One respondent

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commented that disaster aid is costly, unproductive, and selective: "benefits accrue to selected suppliers/recipients". Others reported that they were able to access grant or long-term loan funding through government or financial institutions, or that they were able to negotiate for payment relief for water lease fees ("TNPA were a bit lenient").

One of the six role player respondents was a government department that had developed a COVID-19 response plan based on surveys and identification of critical needs. This was planned to become part of their annual performance plans and would address interventions such as negotiating for deferral of rentals, implementation of longer time frames for the Aquaculture Development and Enhancement Programme (ADEP), promotion of the drive to buy local, and development of recipes for aquaculture products. One role player respondent felt that the current relief schemes were either not readily available, or some companies did not qualify. Most companies made use of the COVID19TERS benefit through the UIF scheme.

Another government department mentioned that they provided support to farmers in the short-term, across all commodities, not only in aquaculture. They also provided social relief to communities such as masks and assistance with grant applications. Another respondent mentioned that they did not receive any COVID-19 support but we're applying for a loan through a bank. There was also a comment made by one respondent about the long-time government took to sort out the Corona Virus Temporary Employer-Employee Relief scheme (COVID19TERS) funding and other relief programs. This led to their organisation helping suppliers through advances based on expected future business.

Table 2: Number of respondents that receives COVID-19 support and their associated Percentages

COVID-19 support	Number of respondents	Percentage (%) of responses
Enterprise case study responses (n=9)	4	44%
Role player responses (n=9)	6	67%

Worldwide, many governments and organisations also provided support to enterprises such as assisted access to domestic markets, easier loan conditions, direct financial assistance, information on coping strategies, securing passes for mobility and connections with new markets (Lebel *et al.*, 2021; Manlosa, Hornidge and Schlüter, 2021). Social support included food aid and emergency subsidy programmes for households. In the Philippines, the two largest telecommunication networks provided free Facebook access for subscribers which aided with online selling and buying (Manlosa, Hornidge and Schlüter, 2021).

3.4. Initiatives for preparation, survival, and rebuilding

Only enterprise case study respondents commented about initiatives they had taken to prepare for, survive, and rebuild after the pandemic, as summarised in Table 4. The most important initiative was long term planning (44%). These respondents regarded the closures as an opportunity to build stock for the future through reseeding on new lines or to obtain finance to get the infrastructure ready for when markets re-opened. They were looking towards the future and felt that they should be patient until they reached their desired production level, as they felt certain that things will go back to normal. One respondent had prepared a COVID-19 management plan, and another had cut down costs as much as possible so they could just survive.

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Table 3: Initiatives undertaken for preparation, survival, and rebuilding after the pandemic with their associated percentages

Themes	Number of Enterprise Case Studies responded (n=9)	Percentage (%) of responses
1. COVID-19 management plan	1	11%
2. Long term planning	4	44%
3. Lean operation	1	11%

The initiatives implemented by South African aquaculture enterprises included Covid-19 management plans, long term planning, and making their operations as lean as possible. These are echoed in some of the recommendations for addressing all aspects of the aquaculture sector, including development of Sector Operational Plans for reducing operational costs, and several long-term strategies, to make aquaculture more resilient in future (Jamwal and Phulia, 2021).

3.5. Factors promoting resilience, survival, and rebuilding

As reflected in Figure 5, for enterprise case study informants the most important factor contributing to resilience and survival was subsidisation or support from associated companies or shareholders (56%). This was especially true in cases where companies were wholly or partly owned by holding companies that provided financing, or individual shareholders that used their savings. Open communication with staff and stakeholders was also important to stabilise operations. Two respondents reported that their ability to build reserve funds in previous years contributed to their resilience and survival. Two others mentioned that being smaller companies meant fewer expenses, which contributed to their resilience and ability to survive.

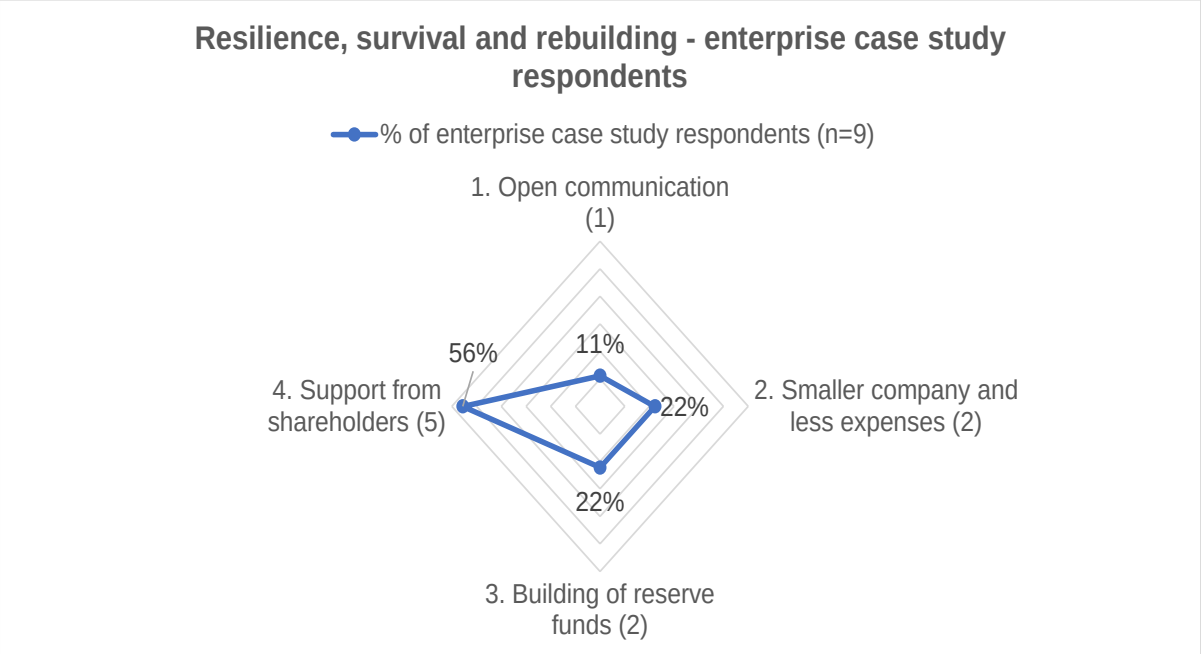

Figure 5: Enterprise case study responses on factors promoting resilience, survival, and rebuilding

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Role player responses regarding factors promoting resilience, survival, and rebuilding after the pandemic are indicated in Figure 6. The most important factor was having cash reserves (44%) with one role player stating, "if you cannot fund the losses, you cannot survive". This referred to companies having intrinsic financial resources and a strong balance sheet based on retained earnings. One respondent mentioned that tax structures need to be changed to incentivise businesses to hold more cash reserves.

Vertical integration and multiple streams of revenue (33%) also contributed to resilience and survival, as large-scale companies usually were integrated, well managed and well capitalised. Good management, innovation, and creativity were also important for long term resilience and survival (44%). Respondents specifically mentioned that some companies were in existence for decades and had "weathered many storms" through good management and that entrepreneurs must be flexible, innovative, and creative in overcoming problems. Another felt that critical success factors should be defined, and that grant funding must be mixed with pure capitalist business drivers to make businesses more sustainable in the long term.

Having diverse markets and species mix, and outside support such as the UIF relief and borrowing from financial institutions also helped. Economies of the scale were identified as an additional factor, where larger, well-managed enterprises had a better chance of survival than smaller community, village, or family-based enterprises. One respondent specifically mentioned the examples of large-scale salmon farms in the North Sea and clustered small-scale enterprises integrated with significant government support such as those found in East Asian countries like China. Another felt that it will only be the "really big" abalone suppliers that will survive in that sector.

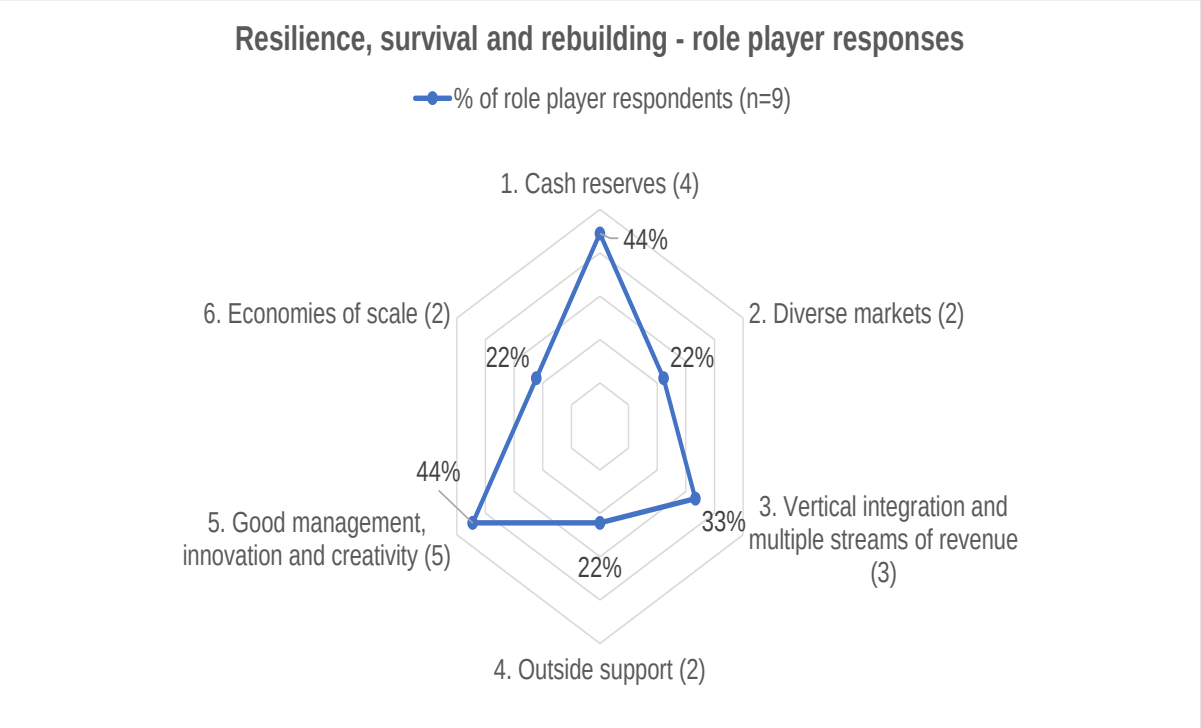

Figure 6: Role player responses on factors promoting resilience, survival, and rebuilding

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On a global scale, coping strategies by producers and fishers included online buying and selling, peddling caught fish in communities, diversifying income and growing their food, marketing and financial measures, changes to crop calendars and rearing practices, seeking new markets, adoption of post-harvest processing, borrowing money, drawing on savings or assets, reducing labour costs, adjusting stocking practices (Lebel *et al.*, 2021; Manlosa, Hornidge and Schlüter, 2021). In the Philippines, the ability of fish farmers and fishers to organise, mobilise and adapt, was an important source of resilience. This was possible because of long-established relationships between the farmers, fishers, and state actors (Manlosa, Hornidge and Schlüter, 2021).

3.6. Requirements to survive and rebuild businesses

Enterprise case study responses on the requirements to survive and rebuild businesses are shown in Table 5. Almost all enterprise case study respondents (89%) noted that financial support is essential to survive and rebuild businesses.

Although some were leaning on holding companies for support, they were investigating alternatives such as low-interest loans offered by the Public Investment Corporation (PIC) or Industrial Development Corporation (IDC) as part of COVID-19 relief programs. Others received moratoriums on existing loans, applied for UIF funding, applied for working capital grants, or were investigating private funding based on using their aquaculture infrastructure as collateral. Although only 33% specifically mentioned access to markets as a requirement to survive, it is assumed that this is an implicit requirement for all enterprises due to the severe impacts of market closures on all enterprises interviewed. Besides the opening of markets (especially the HoReCa industry), respondents mentioned the importance of targeting new export markets, and for government intervention in re-entering or gaining access to new markets.

Table 4: Enterprise case study responses on the requirements to survive and rebuild businesses

Themes	Number of Enterprise Case Studies respondents (N=9)	Percentage (%) of responses
1. Financial support	8	89%
2. Access to markets	3	33%

As illustrated in Figure 7, for role player respondents the most critical requirement for businesses to survive and rebuild after the pandemic, was financial support (78%).

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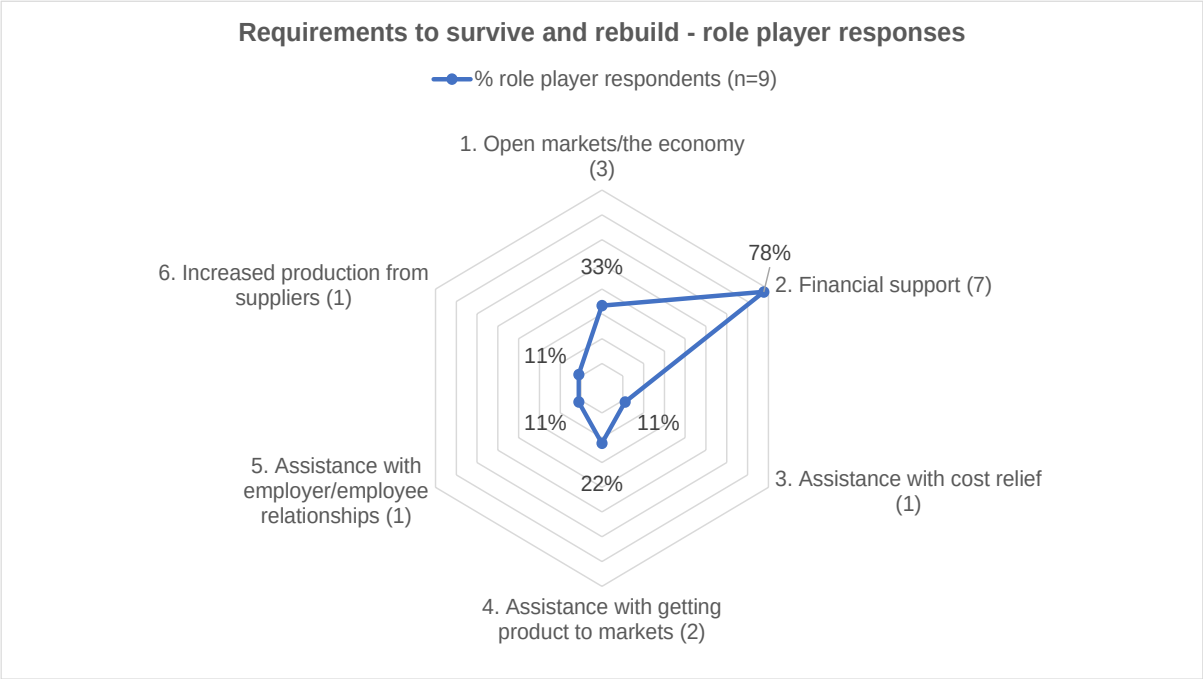

Figure 7: Requirements to survive and rebuild businesses – role player responses

Some of the suggestions included the rescheduling of current short-term business debt (2% per annum or less interest, over 5-15 years), through Treasury, Reserve Bank or commercial banks credit arrangements, subsidisation of salaries, changing of tax structures and continuation of grant schemes. Although only three respondents specifically mentioned the opening of markets, it is assumed that it is a vital requirement, due to the severity of impacts of market closures on businesses. Other suggestions included government assistance with getting the product to markets (e.g., helping with freight and finding markets for surplus products), assistance with cost relief, assistance with employer/employee relationships and helping suppliers to increase their production.

Both informant groups listed loss or closure of markets and resultant loss of sales as the most important impact of COVID-19 on the aquaculture sector. This had various knock-on effects such as overstock, lower prices, loss of raw material, staff reductions and inability to pay operational costs. The most important factors promoting resilience were subsidisation by shareholders and having access to cash reserves.

Similarly, both groups listed financial support and access to markets as the most critical requirements for aquaculture businesses to survive the pandemic and rebuild their businesses. The situation across the world remains dynamic as the pandemic had not been brought under control by October 2021. Despite the development and worldwide roll-out of vaccines, most countries experienced successive waves of infection flare-ups since March 2020, resulting in numerous cycles of increases and decreases of lockdown levels. Therefore, the most important requirement for survival and rebuilding of aquaculture sectors worldwide, the complete re-opening of markets for aquaculture products, remains a moving target. In the interim, the aquaculture industry, supported by the government and other sectors, need to devise and implement strategies to continue surviving, and to rebuild the industry and societies once the pandemic is over. In addition, the threat of future pandemics and global crises such a climate change requires a re-think of how to prepare the aquaculture sector for future shocks.

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Jamwal and Phulia, (2021) describe the COVID-19 pandemic as a One Health issue (a collaborative approach including professionals from various disciplines to address all aspects of the sector including biological and socio-economic issues). Their recommendations (some of which could be considered by the South African industry and government) include identification of free transit of disease-free fish and fish-related products during an epidemic or pandemic, increased trade transparency and traceability, limiting exposure to the international market and catering to local demand, reduction of fishing effort/production, development of Standard Operating Procedures (SOPs) for reducing operational costs, self-reliance in the production of essential items of input, declaration of minimum support price or fair price, protection policies and monetary welfare packages for more vulnerable Small-scale Fisheries (SSFs) and communities that practice sustenance fishing, and leveraging technology to manage farm activities. They also propose the introduction of Internet of Things (IoT) based solutions, strengthening of local markets, innovations in marketing strategies, product traceability and online fish purchasing.

Although the Indian government implemented immediate measures to assist the aquaculture industry, a study on the shrimp farming industry led to further suggestions for short-term (current year) and medium-term (2-5 years) mitigation measures to support seed production, shrimp farming, processing, and marketing, and labour and social system (Kumaran *et al.*, 2021). According to the Food and Agriculture Organization of the United Nations (FAO), COVID-19 related cuts in trade of bivalve shellfish are higher than for other types of seafood, because bivalves are mostly marketed in live form. Lower prices were obtained due to lower demand.

Contrary to most countries, the Spanish mussel processing industry grew in 2020 due to its ability to adapt to the change in consumer patterns to retail marketing of canned mussel products, by diversifying from live mussel products to ready meals and canned products. Bivalve producers and traders worldwide should learn from this example and invest in value addition beyond frozen half shelves to products that can be offered for sales in supermarkets and through home delivery services (FAO, 2021). These and other strategies for the rebuilding of economies and aquaculture sectors worldwide will require access to funding. The World Bank is making available up to USD160 billion especially in developing countries, to strengthen their pandemic response and overcome the health, economic and social difficulties caused by the pandemic (The World Bank, 2021). However, individual countries still need to provide or enable access to financial support.

4. Conclusions

The COVID-19 pandemic is an extraordinary, once-in-a-lifetime crisis with devastating impacts on economies and societies worldwide. The pandemic exposed the vulnerability of aquaculture enterprises to disasters and crises with such wide-ranging impacts. Enterprises with the potential to be self-sustainable under normal circumstances needed to adapt in extraordinary ways to stay in business. This study identified the main impacts on the aquaculture sector as the closure of markets and drop in sales, which led to many other challenges such as loss of production, reduction in staff, financial difficulties, and business closures. The pandemic impacted the ability of role player organisations to continue with their operations and programmes, especially through restrictions on movements and impacts on staff. Although various COVID-19 support schemes were made available, there were challenges and some companies could not readily access such schemes. Enterprises prepare for the pandemic and the future mainly through long-term planning such as getting production structures ready. Some of

the main factors contributing to resilience were subsidisation from shareholders, reserve funds and multiple streams of revenue. The most critical requirements to survive and rebuild the sector was financial support and the opening of markets.

5. Recommendations

Considering the predictions that there may be more frequent pandemics, the lessons learnt during this and other studies can be used for the development of interventions aimed at surviving and rebuilding the sector to be more resilient in future. These lessons should be taken into consideration in the formulation of policy and strategy, especially during the current process to develop an Oceans Economy Master Plan to build on the achievements of Operation Phakisa. This includes the stabilisation, revival and growth of Aquaculture and Fisheries as a sub-sector. Considering the estimation that at least 70% of aquaculture farms risk closure, drastic interventions from stakeholders will be required to revive closed businesses and rebuild the surviving ones. These businesses should be prioritised first before any investment in new aquaculture ventures is considered. Follow-up assessments of the aquaculture industry should be conducted to better understand and quantify the full impacts of COVID-19 on the sector and provide tailor-made solutions for each sub-sector to stabilise, revive and grow the aquaculture sector in the medium to long term. The development of an aquaculture industry-based Business Continuity Strategy should be prioritised to assist existing enterprises with strategies for survival until the pandemic is over, to prepare for normalisation of operations thereafter, and to prepare the sector and enterprises to be more resilient in case of future global crises and disasters.

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