

German aquaculture under Covid-19 – impacts of the pandemic on the sector during 2020

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Abstract – This study sheds light on challenges and possibilities for the German aquaculture sector resulting from the restrictions imposed by the German government to contain the Coronavirus SARS-CoV-2. By presenting results of expert interviews, stakeholder statements and a survey among German fish farmers, we provide insights into distribution, cost and turnover developments triggered by the restrictions in 2020. The survey shows that the pandemic had an impact on the business of a large group of producers: 44% of the fish farmers reported disturbed production processes, 46% experienced a decline in sales and the restricted gastronomy sector impacted negatively on the sales of 79%. On the other hand, 15% of the respondents were able to sell more than in 2019, 27% expanded their sales directly to the consumers. Nevertheless, a great majority (78%) did not perceive the impact of the Covid-19 pandemic as the main challenge of German aquaculture. Based on the gained insights, we estimated the economic impacts of the Covid-19 restrictions on typical German fish farms under three scenarios with EBIT changes ranging from –10% to +8% compared to 2019. In that way, the gained insights teach valuable lessons on the sector's resilience to external shocks. During the scenarios a lack of vertical integration and a dependency on wholesale led to financial challenges. On the other hand, the scenarios attest fish farms with direct marketing structures and diversified distribution channels a higher resilience to external shocks: the small-scale structure of the German aquaculture that was often seen as a weakness on a globalised market proved to be an advantage.

Keywords: Covid-19 / economics / German aquaculture / qualitative-quantitative research / typical farm approach / mixed-method approach

1 Introduction

The multitude of infections around the globe and the rapid transmission of the Coronavirus SARS-CoV-2 turned the Coronavirus Disease Covid-19 into a public health crisis at the beginning of 2020. To avoid collapses of the health care infrastructure due to a capacity overload, prompt measures had to be taken to inhibit the rate of new infections. These measures to contain the pandemic had impacts on industries worldwide. Especially severe were these impacts on food supply chains in general and perishable food supply chains in particular (Mangano et al., 2022). The highly globalised market for aquatic products was no exception as seafood remains one of the most traded food commodities in the world (FAO, 2020) – a fact that simplifies the propagation of shocks (Love et al., 2021).

In contrast to globalised food supply chains that are able to absorb the intensity of regional shocks but are vulnerable to disruptions on a global scale, the majority of the aquaculture enterprises in Germany are small-scale: during 2020, the reference year of this study, 2281 aquaculture enterprises produced a total volume of 32,204 tonnes fish and aquatic products (Destatis, 2021) and employed around 1200 workers (BA, 2021). 55% of these enterprises produced less than 1 tonne. The production volumes of another 18% of the fish farms were less than 5 tonnes (Destatis, 2021). On March 23, 2020, German aquaculture and fisheries – as parts of the food industry – were declared by the German government to be systemically relevant (BMEL, 2020). To avoid supply bottlenecks, aquaculture enterprises were granted the right to emergency childcare and support to guarantee liquidity, functioning supply chains and sufficient workforce. A revision of the former European Maritime and Fisheries Fund (EMFF), now European Maritime, Fisheries and Aquaculture Fund (EMFAF), was introduced to address and to counterbalance impacts of the pandemic.

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Nevertheless, Covid-19 had economic impacts on the German aquaculture sector. The insights of the applied mixed-method approach allow a multitude of perspectives on the dynamics within the German aquaculture sector under Covid-19 in 2020. These gain relevance against the background that precise analyses of these effects help to understand the structures that determine the sector's ability to cope with crisis. That is why the impacts of Covid-19 can teach valuable lessons about the structural strengths and weaknesses in German fish production. Understanding these factors is not only an essential precondition to any considerations about crisis response, it is also fundamental for building resilience for upcoming external shocks, for example caused by climate change.

2 Materials and methods

For this study, a mixed-method approach was applied: first, semi-structured expert interviews were conducted. The results were put into context with a qualitative content analysis of stakeholder statements. A quantitative survey of fish farmers followed. The gained insights were used to build scenarios that were projected on four representative fish farm models ("typical farms").

2.1 Expert interview and stakeholder statements

As experts are carriers of specific technical, process or explanatory knowledge (Bogner et al., 2014) expert interviews were chosen as the appropriate explorative method to access challenges and responses that came up during the beginning of the pandemic in spring 2020. For this study, semi-structured phone interviews were conducted with seven experts affiliated to research institutions, aquaculture enterprises and fish farmer associations. They were chosen based on their profound overview of dynamics within the German aquaculture sector. Their backgrounds and expertise guarantee a balanced composition of the carp, trout and blue mussel industry that represent the main species of the German aquaculture production (Edebohls et al., 2021; Destatis, 2021). The interview guideline used includes eight questions targeted to explore impacts of Covid-19 on the accessibility of labour force and changing dynamics of prices and sales elucidating particularities of different distribution channels (Appendix A). Furthermore, the interviewees were asked to draw assumptions of percentage changes within distribution and prices caused by the restrictions of social and operational activities from March 22 until June 3, 2020.

During the time the interviews took place, the National Strategic Plan for Aquaculture in Germany 2021–2030 (AG NASTAQ, 2020) was revised. Such an aquaculture strategy is mandatory for EU member states to get access to the European Maritime, Fisheries and Aquaculture Fund (EMFAF), which is an important funding program for the sector (EU, 2013). As part of the revision process an open consultation took place from May 24 until June 15, 2020. It consisted of eleven questions that were published by the national agriculture agency (Bundesanstalt für Landwirtschaft und Ernährung) on the website "portal-fischerei.de". They were answered by 27 stakeholders from aquaculture

associations, nature protection agencies, aquaculture enterprises and suppliers, private aquaculture consultants, universities and research institutes. We included the responses to the question: *In your opinion, which consequences arise from the restrictions on economic activities imposed in the context of the current Covid-19 pandemic for the German aquaculture?* into our analysis.

2.2 Survey

Under the authority of the Federal Ministry of Food and Agriculture and against the background of the Data Collection Framework (DCF) of the European Union (EU), economic and social data on the German aquaculture sector are collected annually by the Thünen Institute. The gathered indicators are transmitted to the Joint Research Center of the European Commission, which monitors developments of the EU aquaculture sector (STECF, 2021).

For the data collection in 2020, a standardised questionnaire was sent to 727 German fish farmers. It included two questions on Covid-19: First, the respondents were asked to quantify changes in sales in 2020 compared to 2019. In a second part of the survey, the respondents expressed their opinions on five statements about the overall situation of the sector in times of the Covid-19 pandemic, using a four-point Likert scale (cf. Appendix B). The statements were deduced from the results of the expert interviews and stakeholder statements.

Among the 100 valid responses were 32 from salmonid producers, 51 from carp farms, five from mussel producers and 12 from producers whose production species were categorised as "other".

2.3 Typical farm approach

Typical fish farms are datasets containing information about prices, volumes and costs that can be seen as representative ("typical") for aquaculture enterprises of a certain size in a specific region (Lasner, 2020) allowing detailed insights into the economic situation of the German aquaculture. The values for the datasets are pre-defined based on available statistics and literature. These pre-defined values are the basis for discussion within focus groups with fish farmers. The fish farmers discuss prices, volumes and costs with the aim to compile a multitude of variables for the datasets. The discussion continues until consensus on which operational characteristics can be defined as typical for a particular region is reached. The plausibility of the data is checked during interviews with farmers and observations during farm visits. In a nutshell, values gained from the typical farm approach are what Häring and Klöble call "Faustzahl" (a German term that could be translated into "rule of thumb"):

"A Faustzahl reduces complexity of the core aspects and refers to more than one situation. It delivers memorable and credible values, because it is based on the knowledge of experts. The values are empirical, and cannot be assigned with a higher degree of statistical significance. However, the approach is far from superficial. It gets to the heart of the matter" (Häring and Klöble, 2015; transl. by Lasner).

The typical farm approach is applied by the *agri benchmark* Network (Chibanda et al., 2020). The non-profit network of

scientists, producers and other experts of agricultural value chains around the globe researches on the economic performance of different food production systems such as beef, pig, sheep, dairy, cash crop and horticulture using “typical farms” (agri benchmark, 2022; e.g. Walthers, 2014). In aquaculture, the typical farm approach has proven itself within analyses of the economic impacts of changing framework conditions and adaptation strategies of fish farmers (Lasner et al., 2020), the implementation of technical innovations (Behrens et al., 2019) or the effects of climate change (Kreiß et al., 2020). Moreover, the typical farm approach is best applicable to study the effects of shocks like the Covid-19 pandemic (Chibanda et al., 2020). Details on farm cost calculations used can be found in the relevant literature (Lasner, 2020; Behrens et al., 2019; Lasner et al., 2017; Deblitz et al., 1998).

Four typical farms were selected for the scenario analysis based on their representative character for the German aquaculture sector. Each typical farm is coded: the first letters refer to the ISO 3166-2 country code. The next letters indicate its main species and refer to the FAO 3-alpha code for fish species (“TRR” for rainbow trout, “XXX” for a char hybrid, “FCP” for common carp). The number at the end displays the annual production volume in tonnes (metric tons).

DE-FCP-5 pictures a small-scale carp farm located in the Aischgrund region in Bavaria, where earthen ponds are supplied by precipitation. Within the region, carp farms are traditionally family-owned and often operated as side businesses. DE-FCP-5 focuses on grow-out only. The fingerlings are bought from other farms and the carps for consumption are sold to a large regional wholesaler that depends on the gastronomy sector.

DE-FCP-80 represents a medium-scale carp farm with traditional earthen ponds located in Upper Lusatia in Saxony with capacities to store living fish for consumption. As typical for the region, the enterprise produces its own stock to avoid the transmission of diseases between fish farms. It covers all production steps including processing. The main share of the produced fish is distributed via wholesale. Smaller quantities are sold to restaurants and angling clubs. As most of the pond surface of Saxony is under nature conservation, DE-FCP-80 receives public payments for services of nature protection.

DE-XXX-25 produces char and rainbow trout in earthen ponds. Additionally, trout which remain longer in the production system are sold under the tradename “salmon trout” (Lachsforelle). The farm replicates a Bavarian medium-scale farm with a specialisation in direct marketing.

DE-TRR-500 represents one of the largest salmonid farm types in Germany and is located in Baden-Württemberg. It produces in modern raceways and sells mostly to wholesalers. A minor part of fingerling production from the integrated hatchery and nursery is sold to other farms.

2.4 Scenario analysis

For the scenario analysis the data sets of the typical farms were extrapolated to a common **Baseline (0)** scenario 2020. In a second step, the scenarios **Lockdown (1)** and **Dancing with the Virus (2)** (inspired by Isermeyer (2020)) were developed. The specific costs and prices for the typical farms during each scenario were projected using price indices from agricultural and aquaculture statistics (Destatis, 2021a, 2021b, 2021c, 2021d, 2021e). The changes in sales volumes distributed via wholesale, retail (to other farms), stocking (for other farms and

angling clubs) and direct marketing were inferred from mean values of the survey among fish farmers (cf. Sect. 3.2). Official statistics were used to identify changes within the distribution to gastronomy (Destatis, 2021f). As carp and salmonid farms produce for different market segments, there are specifications of the scenarios depending on the species produced (cf. Tab. 1). Table 1 provides an overview of the scenarios.

The **Lockdown** scenarios (1) mirror the variances of restrictions imposed on public and economic life in Germany from March 22 to April 15, 2020 and November 2, 2020 to March 1, 2021. For the variations 1A and 1C, sales in April 2020 were compared to April 2019. For the “winter-sale” scenario (1B), the sales in December 2020 were compared to December 2019. Closed hotels, restaurants and catering (HORECA) with a sales decrease of −75% compared to 2019 (Destatis, 2021f) characterise all variations. The Lockdown scenarios focus on short-term impacts (one month). In the **Lockdown scenario (1A)** the “carp-to-go” initiative is included with fish restaurants offering a takeaway service with ready-made carp meals in reaction to the closure of the HORECA sector in spring 2020 during the peak sales period Easter in Bavaria. For salmonids, the demand via direct marketing increases in the 1A scenario as people stay in their home region during the lockdown instead of travelling abroad, prepare meals instead of dining out and are more aware of regional products. The slight **Lockdown scenario (1B)** “winter sales” mirrors the circumstances of a Lockdown in winter 2020—another peak period for the carp sector — when in particular carp farms in Saxony benefited from reduced imports from the Czech Republic and Poland that resulted in higher wholesaler prices. Information on regional particularities for the variations 1A (Bavaria) and 1B (Saxony) were gathered during the expert interviews.

The **Dancing with the Virus** scenarios (2) include a pandemic adaptive management, which balances restrictions and their gradual easing for the public life while focussing on the mid-term consequences in the course of the year. For the Dancing with the Virus scenarios (2), the mean changes in the first half of 2020¹ were compared to the year 2019. For the variation 2A (with easing restrictions) decreases were defined as the mean values and increases in sales volumes as high increases (mean plus standard deviation) expressed during the survey. Direct sales and sales to fish farms, angling clubs and processors increase by 20% for carp and 25% for salmonid. Sales to wholesale remain stable at the level of 2019. Losses due to the crisis of the gastronomy sector can be balanced with a higher demand from other channels. Only the impacts of the closed HORECA sector are negative on an annual average (−40% according to Destatis, 2021f). The decreases during the scenario variation 2B (that includes a resumption of the restrictions) base on mean values plus standard deviation as well. The impact of the closed gastronomy sector on wholesale demand is assumed to be more intense (−30% for salmonids and −50% for carp) and the increase of direct marketing lower than in 2A. Notwithstanding, sales are better than under the Lockdown scenarios (1A-C). Within variation 2B of Dancing with the Virus (2), the impacts on the gastronomy sector are less intense (−40%). The demand in direct marketing increases

¹ Data from the first half of 2020 was the last data available before the study was submitted for publication.

Table 1. Overview of the Covid-19 impact scenarios.

Scenario	Scenario variation	Farms	Impacts on sales volumes compared to 2019				Price development
			Wholesale	Other farms and angling clubs	Gastro-nomy	Direct marketing	
BASELINE (0)							
Baseline	0	all	no changes compared to 2019				
LOCKDOWN (1)							
Slight lockdown <i>Carp-to-go</i>	1A	DE-FCP-5 only (carp)	-30%	+20%	-75%	+20%	NR
Slight lockdown	1A	Salmonid farms	-20%	+25%	-75%	+25%	NR
Slight lockdown <i>Carp winter-sale</i>	1B	DE-FCP-80 Only (carp)	0%	0%	-75%	0%	+10%
Harsh lockdown	1C	Carp farms	-50%	-100%	-75%	+10%	NR
		Salmonid farms	-30%	-100%	-75%	+15%	NR
DANCING WITH THE VIRUS (2)							
Low restrictions	2A	Carp farms	0%	+20%	-40%	+20%	NR
		Salmonid farms	0%	+25%	-40%	+25%	NR
Harsh restrictions	2B	Carp farms	-50%	+10%	-40%	+10%	NR
		Salmonid farms	-30%	+15%	-40%	+15%	NR

(+15% for salmonids and +10% for carp) because people shop locally due to limited mobility. Some farms increase production and sales capacities or adapt sale channels to this alteration. Fish prices stay stable throughout the year and all farms benefit from lower diesel prices during 2020.

All degrees of sales changes were rounded to intervals of five in all scenarios. Finally, a full-cost accounting and a profit and loss account were calculated for each scenario, variation and farm including income and Earnings Before Interest and Tax (EBIT) margin:

$$EBIT = (\text{fish farms' returns} + \text{public payments}) - \text{wages} \\ - \text{value of unpaid labour} - \text{variable costs} \\ - \text{fixed costs} - \text{depreciation}$$

$$EBIT_{\text{margin}} = \frac{EBIT}{\text{turnover}} * 100.$$

Alterations in Value-Added Tax (VAT) implemented by the German government from June to December 2020 had no impact as all values are calculated without VAT. Expert interviews and the stakeholder statements provided background information, which helped to interpret and verify the calculated results.

3 Results

3.1 Results of the interviews and stakeholder statements

The temporary closure of restaurants right before Easter posed an intense challenge for freshwater producers. Due to this important selling season the production systems were used to capacity when restrictions came into force. As these restrictions led to the absence of certain distribution channels, blockage effects and disruptions in production flows occurred.

In the federal state of Bavaria, the concept of “carp-to-go” was developed to compensate losses and to sustain the tradition of eating carp during Holy Week. Expressions of appreciation from the consumers for providing fresh and regionally produced food during times of crisis were reported during the interviews. In Saxony there were also attempts to compensate losses through deliveries. The intents undertaken by trout producers in Baden-Württemberg to enter supra-regional retail trade were not successful: according to the interviewed experts, the offered prices were perceived as too low to make supra-regional retail a feasible alternative distribution channel.

A positive trend was observed for farm shops as they were not affected by temporary closures. Travel restrictions led to what

was called “rediscovery of regional food production” during one of the interviews. Especially small producers could benefit from the positive trend in direct marketing as it was easier to sell their small production volumes directly to the consumer despite limited regional demand. Even increases of more than 100% of sales for individual farm shops were brought up during the interviews. These strong examples cannot be generalised but seen as indicators that Covid-19 initiated certain dynamics from which direct marketing could benefit.

While angling ponds were open continuously in Saxony, they were closed until mid of April 2020 in North Rhine-Westphalia and the end of April 2020 in Baden-Württemberg. During that time period, stocking did not take place as usual – a fact that led to organizational challenges and cancellations within the trade of living fish. After the reopening of angling ponds, a positive trend was observed: the possibility to angle alone and outdoors, more time, the uncommonly good weather in combination with the absence of other possible leisure activities were mentioned as reasons behind this development. The effects of closed angling ponds in France were felt in North Rhine-Westphalia in the form of oversupply. French producers offered their products more cheaply than usual on the German market to respond to the overcapacity within their production systems. These activities triggered a certain degree of price and volume pressure. Due to its location, Baden-Württemberg was affected by the closed borders for touristic purposes to France, Switzerland and Austria in the form of absence of clients that cross borders to purchase foodstuffs. In Bavaria, carp harvesting normally takes place with involvement of auxiliaries from the Czech Republic and Poland that could not travel due to travel restrictions. Thus, some difficulties recruiting workers were experienced, also due to concerns of volunteers regarding potential contagion.

In Bavaria the demand for fresh fish rose. Due to working at home, short-time work and limited leisure activities, more time was available to cook freshly. Furthermore, the impossibility to eat at canteens or restaurants also pushed the demand for fresh products.

Shifting the perspective to possible long-term effects mentioned during the interviews, it must be said that due to the insecure selling situation during spring 2020, some Bavarian carp producers restocked the fish after harvesting. Holding fish in the water until the market improves is only possible for a limited time and obviously causes additional costs (Love et al., 2021). Furthermore, it leads to a lack of production area and to interruptions of production procedures. Public payments are coupled to requirements regarding the stocking rates of the supported ponds (“Kulturlandschaftsprogramm”). Due to the special circumstances, the allowed stocking rate in Bavaria was temporary increased by 30% (Teichgenossenschaft Aischgrund, 2020). Certainly, for upcoming seasons, this could cause shifts within supply regarding the offered fish sizes and available volumes. Such second order impacts and lagged shifts in trade take longer to become visible and are expected on global scale (Love et al., 2021). Another aspect that kept especially carp producers in Saxony concerned was the festivities relating to the opening of the carp season hosted in fall. As they are important economic factors for regional carp production, the question if and how they can take place determines future economic performances. Lastly, the availability of ingredients for feed was identified as a crucial factor

for the upcoming months. Especially the protein components soy, fish oil and fish meal are produced mainly in South America, which was badly hit by Covid-19. This fact could eventually cause bottlenecks affecting feed prices and quality.

German blue mussel producers could profit from high prices during the second half of 2020. The prices resulted from a demand surplus at the end of the year and led to high turnovers. This surplus was partly based on the fact that during spring (when the gastronomy sector and the mussel auction in Yerseke were closed), mussel farms located in the southern part of the North Sea did not prepare the harvest of mussels for sale in the second half of the year as they usually do. Furthermore, logistics were disturbed and mussel vessels – as they could not ensure social distancing on board – stayed at the port. In consequence, a significant part of mussels for consumption were not shifted from winter on-bottom storage cultures to shallow, sale storage cultures, where they usually get a final growth boost. The described impacts affected the mussel firms in Lower Saxony more than in Schleswig-Holstein, where firms could sell their harvest in the first quarter of 2020 because of better natural conditions. However, blue mussels cultures that are not shifted are exposed to winter storms and other negative impacts.

3.2 Results of the quantitative survey

While 34% of the surveyed salmonid producers ($n=32$) and 41% of the surveyed carp farmers ($n=51$) did not experience any developments with regard to their sales due to Covid-19 (cf. Fig. 1), none of the surveyed mussel producers ($n=5$) reported unchanged sales: a clear majority of 80% of the mussel enterprises could sell more than the previous year, the remaining 20% had to cover losses. This high variance may not be surprising against the background that the volume of German mussel production is typically subject to changes due to climatic or market related developments. This characteristic makes it difficult to compare the mussel to the fresh water aquaculture and is the reason why the sales developments of the salmonid, carp and blue mussel enterprises triggered by the Covid-19 pandemic are dealt with separately in the following discussion.

As apparent in Figure 1, the share of salmonid producers who were able to sell more compared to 2019 (22%) is considerably higher than among carp farmers (6%). Examples of producers who have expanded their direct marketing during the pandemic were indicated by all interviewed experts (cf. 3.1). Broaching this subject again during the survey, it became evident that a bit more than one quarter of all fish farmers (27%) was able to enlarge sales directly to the consumers in 2020 (cf. Fig. 2).

This share was significantly higher among salmonids producers (44%) than among carp producers (16%). Nearly half of the surveyed producers (46%) agree with the assumption that the small-scale structure of the German aquaculture sector with its focus on direct marketing proved to be of advantage during the Covid-19 pandemic. Again, while a clear majority of salmonids producers shares this view (66%), only 41% of the carp farmers do. Including the blue mussel sector into examination, it can be said that none of the respondents could expand their direct marketing. Correspond-

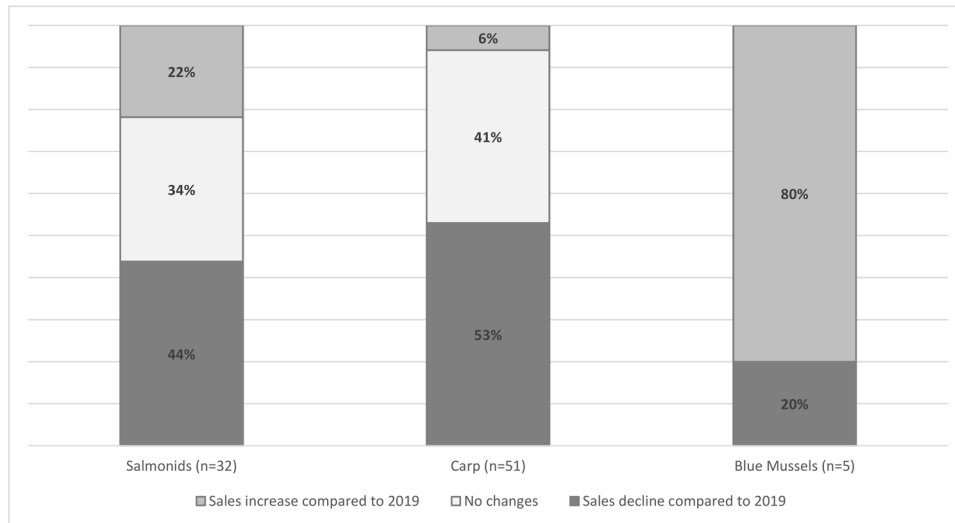


Fig. 1. Sales development in 2020 compared to 2019.

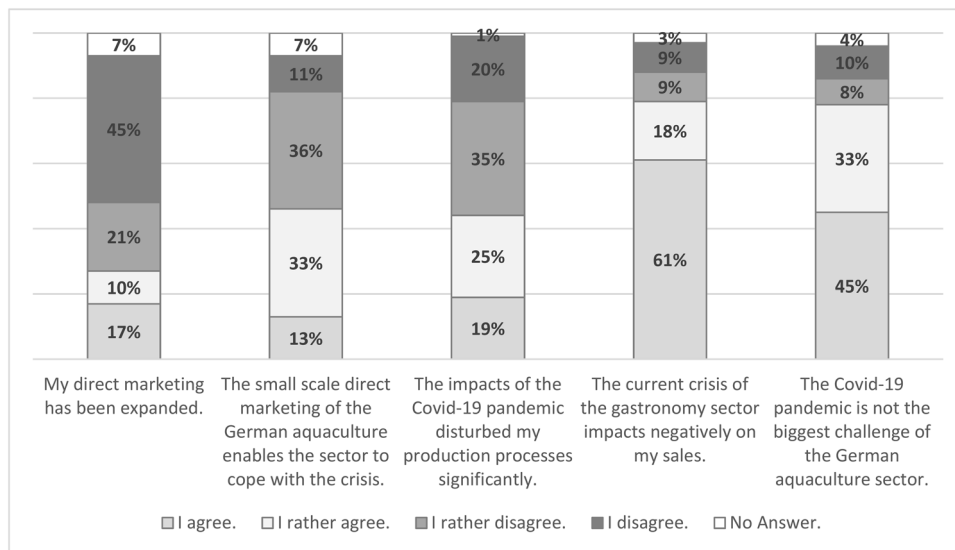


Fig. 2. Fish farmers' appraisal of the Covid-19 pandemic during 2020—average all species (n = 100).

ingly, the same share (100%) disagreed that the small scale of the German aquaculture can be perceived as an advantage during times of crisis. Nevertheless, these answers need to be understood within the context of the structure of distribution channels of blue mussel producers: while direct marketing is rather irrelevant, the highest prices for mussels are generated through the gastronomy sector. Its current crisis does not only impact negatively on the mussel production but the whole German aquaculture sector as the following paragraph illustrates.

In contrast to the examples of positive developments for the direct marketing under Covid-19 in 2020, sales dropped for 44% of the surveyed salmonid producers and 53% of the carp producers while only 20% of the mussel producers had to cover losses. During the interviews, the shutdown of the gastronomy sector as an important distribution channel was identified as one of the greatest economic challenges Covid-19 has posed for the sector. This assessment was shared by a strong majority

of all surveyed producers: almost 80% experienced negative impacts due to the closure of restaurants (cf. Fig. 2) — respectively 72% of the salmonids, 8% of the carp and 100% of the mussel producers.

When asked to estimate the intensity of Covid-19 impacts, the interviewed experts pointed out that there are currently more pressing challenges for the sector than the Covid-19 crisis. The fact that more than half of all surveyed farmers (55%) stated that their production processes have not been disturbed significantly by the Covid-19 crisis already implies the validity of this notion. As for the surveyed carp farmers, 39% agreed that impacts of the pandemic disturbed their production processes (50% of the salmonid producers), while 61% disagreed. And indeed, a great majority of 78% of all fish farmers indicated that they do not perceive the Covid-19 pandemic as the biggest challenge of the sector.

The following specifications on the perception of the intensity of the damages caused by the Covid-19 crisis can be given for the

Table 2. Characteristics, profit and loss account, Earnings before Interests and Tax (EBIT) margin of the typical farms in the Baseline scenario (1. quarter 2020).

Farm	DE-FCP-5 0-BC	DE-FCP-80 0-BC	DE-XXX-25 0-BC	DE-TRR-500 0-BC
Region	Aischgrund (Bavaria)	Upper Lusatia (Saxony)	Bavaria	Baden-Württemberg
Main technique	Earthen pond	Earthen pond	Earthen pond	Raceway
Species	Common carp	Common carp	a) char, b) rainbow trout, c) salmon trout	Rainbow trout
Sales channels (share refers to kg sold to)	Wholesale (100%)	Wholesale (70%), fish farms (5%), restaurant (5%), processors & fish mongers (10%), direct marketing (10%)	Direct marketing (92%), fish farms (8%)	Wholesale (100%)
Sales volume in kg/year	5,000	80,000	a) 25,000 b) 7,500 c) 7,500	500,000
Profit and loss account				
Total turnover (€)	69,292	288,827	570,199	2,063,029
Other income (€)	57,621	—	—	—
Income from fish farm				
Turnover fish farm (€)	11,671	288,827	570,199	2,063,029
Hatchery & Nursery	—	3,911	—	18,475
Grow-out	11,671	167,597	21,191	1,960,800
Direct sales	—	64,820	549,008	—
Public payments	—	52,500	—	83,754
Operating costs (€)				
Variable costs (—)	4,151	75,811	130,331	727,365
Fixed costs (—)	3,069	59,952	32,853	135,601
Wages (—)	—	41,869	32,954	214,173
Net farm income	4,450	111,196	374,062	985,890
Depreciation (—)	15,673	65,901	67,835	356,748
Farm income	–11,223	45,295	306,227	629,141
Value unpaid labour (—)	5,889	51,045	133,874	50,394
Fish farm's profit	–17,112	–5,750	172,353	578,748
EBIT margin (%)	–3%	–1%	14%	8%

blue mussel sector: 80% of the surveyed producers stated that their production processes have been disturbed significantly. 20% seem to have experienced only slight disturbances. All surveyed mussel producers agreed that the Covid-19 pandemic is not the biggest challenge of the German aquaculture sector, but rather growing sedimentation, intensifying extreme weather events and worsening conditions of the stocks.

3.3 Results of the Covid-19 impact scenarios

The following section presents the estimated economic performances of each typical farm under the scenarios explained in [Section 2.4](#).

3.3.1 Baseline 2020

The owner of **DE-FCP-5** is a part-time farmer who receives his main income as an employee and additional income from an agricultural crop farm. Both can be considered “typical” for small carp farms in Bavaria. Right before the restrictions were

implemented **DE-FCP-5**'s EBIT margin was –2%. Including the value of his unpaid labour, it further decreases to –3%. Considering only the operating costs of **DE-FCP-80**, the farm's EBIT margin was 4% in the first quarter of 2020. Nevertheless, the enterprise is not able to cover its costs for linear depreciation and the value of unpaid labour, a fact that leads to a negative EBIT margin of –1% in the long-term. This negative trend cannot be fully compensated by the public payments of €350 per hectare, which **DE-FCP-80** receives. During the first quarter of 2020, **DE-XXX-25** had an EBIT margin of 14%, making it a top farm. **DE-TRR-500**'s modern production system led to an EBIT margin of 8% in the Baseline scenario.

[Table 2](#) shows an overview of the economic performance of each typical farm right before Covid-19 affected Germany- the Baseline scenario 2020.

3.3.2 Results of the “Lockdown” scenarios

During **Lockdown (1A)** **DE-FCP-5** benefits indirectly from the Bavarian “carp-to-go” initiative (cf. [Sect. 2.4](#)).

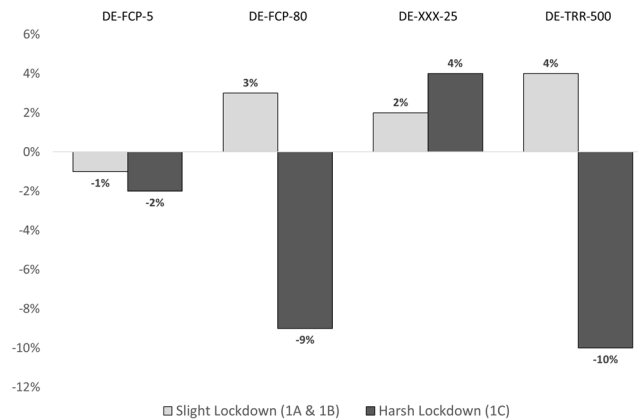


Fig. 3. Changes in EBIT margins of the typical farms during one month of Lockdown compared to the Baseline 2020.

Notwithstanding, DE-FCP-5 depends on wholesale as it has neither the infrastructure for direct marketing nor the capital to create it. For smallholders in the region Aischgrund, it is assumed that all carp is harvested and sold to one middleman during the peak sales season Easter. Under Lockdown (1A) the wholesale demands 30% less due to the pandemic. Unsold carp remain in the ponds causing additional feed and labour costs. In absolute terms, the impact of Covid-19 restrictions on DE-FCP-5 leads to (additional) losses of –€524 per month.

DE-XXX-25, which is specialised in direct marketing, could have benefitted from the change in consumption behaviour during the Lockdown. But the boom of regional products occurred too sudden to adapt DE-XXX-25's production capacity. Under this scenario, the market for salmonids is empty due to the unexpected high direct sales. Additional fish cannot be purchased. In consequence, DE-XXX-25 does not benefit from extra sales (volumes). But the increased demand for DE-XXX-25's products lowers energy and feed costs as fish are sold more quickly than usual. These indirect impacts from the strengthened demand in direct distribution lead to an increased EBIT margin of +2% compared to the Baseline and a plus of €3,334 for one month under Lockdown (1A). The same applies for **DE-TRR-500**: The decreased demand from the wholesale channel is compensated by an increased demand for trout from direct marketers. DE-TRR-500 sells more fish in a shorter period for higher prices. Nevertheless, it is unable to increase its production capacity in the short-term. The raised sales to angling clubs, other fish farms, smokeries and processors lead to an increased EBIT margin of +4% in scenario 1A. Nevertheless, the production processes of DE-XXX-25 and DE-TRR-500 are highly disturbed in this scenario. It is uncertain, if the higher demand is sustainable and near future production volumes can keep up. The availability of additional fingerlings on the market is not plannable to ensure a continuous production during the rest of the year.

During **Lockdown "winter sale" scenario (1B)** lower carp imports cause increased wholesale prices during the Christmas season that positively impacts **DE-FCP-80** which has a focus on wholesale. Notwithstanding, prices first dropped from €2.05 per kg live weight (LW) in April to €1.69 per kg LW in autumn 2020. Afterwards prices increased by 30% to €2.20 per kg LW for the above-mentioned reasons. Compared to 2019 this is a plus of 10%. During the winter season, carp that could not be distributed to restaurants are sold to wholesalers reaching

higher prices. This circumstance leads to an EBIT margin increase of +3% and a plus of €20,000 in DE-FCP-80's profit at the end of the year.

The impacts of the **Lockdown scenario (1C)** on the EBIT margin are more intense for the typical farms without the ability to sell the majority of their products directly to the consumer. The EBIT margin compared to Baseline declines for DE-FCP-5 by –2%, for DE-FCP-80 by –9% and for DE-TRR-500 by –10%. Unsold fish remain in the production systems increasing operational (feed, labour and energy) costs and blocking space for growing fingerlings. Only DE-XXX-25 is able to increase its EBIT margin by 4% in the short-term for one month of Lockdown due to its already existing direct marketing infrastructure (processing facility and farm shop) for the total harvest. Nevertheless, the annual production process for salmonid farms is disturbed. The mid-term consequences of such disturbances are uncertain.

Figure 3 gives an overview of the economic performances under the Lockdown scenarios 1A, 1B and 1C.

3.3.3 Results of the "Dancing with the Virus" scenarios

Even during the **2A** variation of the Dancing with the Virus scenario that is based on less intense restrictions **DE-FCP-5's** EBIT margin decreases by –1% compared to the Baseline. DE-FCP-5 depends indirectly on sales to restaurants through wholesalers and alternative sale opportunities are absent. In contrast, **DE-FCP-80** is able to sell more carp directly to the consumers or to small processors to balance its losses to a certain extent. Volumes originally produced for wholesale are shifted to direct marketing with a higher profit-margin. This leads to an overall increase of the EBIT margin of +4% compared to the Baseline 2020. While it is assumed that due to its farm infrastructure and available labour DE-FCP-80 is able to cope with the relatively minor increase of direct sales compared to its total capacity (4 tonnes of total 80 tonnes), DE-XXX-25 is not capable to do so.

DE-XXX-25 meets the higher demand in direct sales by purchasing extra 10 tonnes of salmonids from other farms. For processing and direct marketing, the owner employs three casual employees with an additional work input of 1900 hours a year. Despite increased costs for raw material, labour and

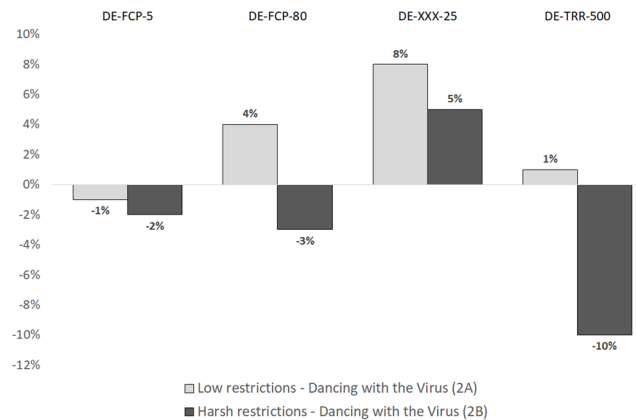


Fig. 4. Changes in EBIT margins of the typical farms during the Dancing with the virus scenario compared to the Baseline 2020.

processing, the turnover of additional 10 tonnes leads to an increased EBIT margin of +8% without essential investments in the infrastructure. **DE-TRR-500** benefits indirectly from the increased demand from its clients, including direct marketer and fish mongers. Its EBIT margin increases by +1%.

The more intense restrictions taken as a basis for the Dancing with the Virus variation **2B** result in EBIT margin decreases for farms that distribute the majority of their production via wholesale: by -2% (−€700 per month) for DE-FCP-5, by -3% (−€3,700 per month) for DE-FCP-80 and by -10% (−€57,000 per month) for DE-TRR-500. During the 2B scenario, the only farm that benefits from the increased demand from direct marketing is DE-XXX-25. It purchases additional 6 tonnes for processing and direct marketing. The owner employs two casual employees with an additional work input of 800 hours a year. In this way, DE-XXX-25 enhances its EBIT margin by +5% (€6,000 per month) despite increased operational costs.

Figure 4 shows the overall EBIT margin development under the Dancing with the Virus scenario.

4 Discussion and conclusion

With Covid-19 transcending national borders, different actors around the globe had to react to the same external shock, at more or less the same time, but under different circumstances. With failures and achievements becoming visible, the transnationalism of the pandemic enables answering research questions such as: Which crisis responses do work, where, when and why? These questions acknowledge the embeddedness of crisis responses into regional, temporal and socio-economic environments and serve as a productive framework to develop strategies to build resilience for upcoming crises. This embeddedness is especially relevant for the German aquaculture sector that is characterised by its diversity regarding production systems, volumes and species produced. For this reason, the impacts of the pandemic cannot be generalised: the particular characteristics of specific enterprises define their resilience to external shocks. This diversity, on the other hand, allows for the comparison between different production systems, applied strategies and methods and their abilities to cope with crisis that enables the identification of improvement potential (Mangano et al., 2022). And indeed,

also during the Covid-19 pandemic some actors have shown to be more resilient than others (Love et al., 2021).

In addition, there were some general developments determining the initial situation of the sector at the beginning of the pandemic: the heat of the past summers in the south of Germany affected the availability of water for trout production. Furthermore, for some trout farmers the Infectious Hematopoietic Necrosis virus (IHNV) represented an additional stressor. The German carp sector entered the Covid-19 crisis in a weakened condition due to droughts, high fish losses due to predation and low wholesale prices. The typical carp farms used in this analysis were not profitable in the long-term before the pandemic. These difficult economic framework conditions certainly intensify the lack of successors as a general phenomenon within German carp production. Due to a general higher demand for salmonids in Germany (FIZ, 2022), salmonid farms are in better market position. Nonetheless, there are large regional differences. For the German mussel production, high variances and unpredictable falls of wild mussel seeds, the growing sedimentation of the coastal zone in Lower Saxony caused by construction sites, climatic changes and predators challenge the sector.

This said about the initial situation of the German aquaculture sector right before the restrictions to contain the pandemic came into force, the shutdown of the gastronomy sector and changing consumer patterns manifesting in a higher demand in direct marketing were identified as the main aspects determining the intensity of Covid-19 impacts on the sector. The examples of fish farms mentioned during the interviews that were able to increase their sales directly to the consumers during 2020 cannot be generalised but seen as indicators that the Covid-19 crisis initiated an orientation towards local shops from which direct marketing could profit. This dynamic must be understood in the context of Covid-19 revealing the downsides of globalised markets and supply chains: namely affected product availability. At the beginning of the pandemic, panic buying in the face of the announced restrictions led to the unavailability of some products, such as sanitary products and staple foods. This situation was a completely unknown experience for most German generations. As supermarkets were perceived as spots for gatherings of people, the purchasing in local farm shops and outdoor farmers' markets appeared as an attractive opportunity to avoid crowds while supporting regional food production with short supply chains

and vertical integration. The restricted mobility and the avoidance of long distances played a decisive role as well. Against this background, it does not surprise that the scenarios attest farms with infrastructure for direct marketing a high resilience to pandemic impacts. During discussions on the performance of the direct marketing under Covid-19, the small-scale structure of the German aquaculture with production volumes that enable sales directly to the consumer was thereby mentioned as one key characteristic determining the resilience of the sector.

The scenarios and their impacts on typical farms remain ideal types. The conducted survey among fish farmers shows the large range (between –90% and +20%) of loss and profit in turnover during the pandemic. The reduction of the complexity of the actual situation within the sector is one of the scenarios' inherent criteria. Nonetheless, the typical farms are grounded on fish farmers' experiences shared in focus groups and the scenarios on the results of the conducted survey. While the Lockdown scenario only illustrates a few weeks, the Dancing with the Virus scenario can serve as a starting point to strengthen economic resilience to future crises through the support of business model diversification and intensification of direct marketing. A lack of vertical integration and a dependency on the gastronomy sector led to challenges regarding the profitability during the scenarios. This must be understood against the background of already existing weaknesses within the sector that were intensified by the pandemic: 78% of the surveyed producers do not see the Covid-19 crisis as the main concern for their businesses. Factors commonly mentioned that are putting the sector under pressure are rather the high losses due to predators, climatic changes, diseases, lacking successors, investment backlogs and bureaucratic obstacles. However, the German aquaculture sector has often been criticised for its low competitiveness. Small-scale farms, which are specialised in direct marketing have been seen as a weakness in an international market. Within the context of a global crisis with affected commodity chains, the ability to produce and sell regionally turned into an advantage.

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Appendix: A

Interview guideline (translated into English)

On March 22nd 2020, the Federal Government of Germany implemented restrictions on the public and economic life in order to contain the spread of Covid-19 and to gain control over the pandemic.

Part 1–Phase of restrictions

1. Please describe the consequences of these restrictions for carp/trout/blue mussel farming in your region.
2. Please describe the impacts of the restrictions on the sales of the sector.
Please express the deviation as a percentage using the sales of the “pandemic free” April 2019 as a reference point (April 2019 = 100%).
What are the differences in wholesale, resale and direct sale?
Please express the sale changes for each sales channel as a percentage.
3. How did product prices develop in April 2020?
Please express the deviation as a percentage using prices under normal conditions as a reference point (April 2019 = 100%).
4. Due to which factors did labour shortages occur (e.g. child care, illness)? What were the consequences?
5. Please describe further consequences and developments (positive or negative) of the restrictions to contain the pandemic for the sector.

Part 2–Loosening phase

1. Please describe the measures of loosening the restrictions implemented in your region and their effects for the sector.
2. Which developments do you expect for the sector for the coming month?
Please express your assessment of sales developments under presumed steady loosening of the restrictions as a percentage using the sales of April 2019 as a reference point (April 2019 = 100%).
Please express your assessment of price developments under presumed steady loosening of the restrictions as a percentage using the sales of April 2019 as a reference point (April 2019 = 100%).
3. Which other aspects are important but were not yet discussed during the interview?

Appendix: B

[DCF questionnaire \(translated into English\)](#)

Data collection in the fisheries and aquaculture sector

Based on the Regulation 2017/1004 of the European Parliament and of the Council

Covid-19 pandemic 2020

What are the consequences of Covid-19 in regard to the market sales?

Sales increased by ____% compared to 2019.

Sales decreased by ____% compared to 2019.

Which statement would you agree to?

	I disagree	I rather disagree	I rather agree	I agree
My direct marketing has been expanded.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The small-scale direct marketing of the German aquaculture enables the sector to cope with the crisis.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The impacts of the Covid-19 pandemic disturbed my production processes significantly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The current crisis of the gastronomy sector impacts negatively on my sales.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The Covid-19 pandemic is not the biggest challenge of the German aquaculture sector.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Thank you for participating!