RESEARCH ARTICLE

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Impact of COVID-19 on the productivity of ornamental fish farmers: A case of ornamental fish farms in Colombo district in Sri Lanka

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Abstract

Ornamental fish production in Sri Lanka has become a valuable foreign exchange earner during recent past years. However, COVID-19 pandemic has been explored worldwide and it has affected the world trade and economy from different perspectives. This study was conducted to explore the impact of the COVID-19 pandemic on ornamental fish production. , Moreover, study on present status of ornamental fish farmers' major constraints and suggestions to overcome those constraints of ornamental fish farmers were also conducted. In Colombo district, four important Divisional Secretariat (DS) divisions were purposely selected for the study, as they are the main ornamental fish production areas of the district. The data was collected from a randomly selected 60 farmers using a field survey from July to October 2020. Descriptive statistics, two sample Wilcoxon signed-rank test and chi-square test were used to analyses the data. Results revealed that, there are both negative and positive impacts on ornamental fish production due to the COVID-19 pandemic. Ornamental fish farmers have to face mainly production and marketing problems. Some of them have engaged in coping strategies and resilience methods during COVID-19 period. Coping strategies have shown a significant association with the income and the production capacity of the farms. However, the majority of ornamental fish farmers haven't engaged in resilience methods during the COVID-19 pandemic. Other than the COVID-19 pandemic, the major constraints of ornamental fish production were lack of market information about the changes in the overseas markets and demand, the low price given for the product and lack of communication between farmers and exporters. Ideal "ORNAFISBIZ" model is suggested for overcome those constraints in order to protect the ornamental fish farmers in this area.

Keywords: Colombo district, COVID-19 pandemic, Negative impacts, Ornamental fish, Present status

INTRODUCTION

Ornamental fish production is a vital part of the aquaculture industry in many countries. Ornamental fish are the most popular pets in the world, and ornamental fish keeping is the second most popular hobby after the photography because of their amazing shapes, dazzling colors, and behavior. The decorative fish is known as the "Living Jewels" fish. Ornamental fish industry in Sri Lanka has a lot of promise, thanks to the country's vast geography, diverse species, and substantial research and development efforts previously made by the relevant

organizations. Due to the great economic opportunities and prospects, it is quickly gaining attraction. Ornamental fish farming and their propagation have an attractive activity for many people in the world, which provides not only aesthetic beauty and pleasure, but also financial benefits. As a result, ornamental fish industry has become a multibillion-dollar industry in the world. Initially, ornamental fish keeping was mostly a hobby practiced in rich countries. But it has recently gained popularity in developing countries as well.

Sri Lanka has a tropical climate country in the world. As a result, the aquarium sector is well-suited to various parts of the country (Perera, 2009). Freshwater, marine, and brackish water species are the main parts of Sri Lanka's ornamental fish industry. About 50 years ago, a few entrepreneurs pioneered ornamental fish farming. Since then, it has grown into a booming sector with an export market, providing profit and employment to a large number of people. As a non-food fishery industry, the aquaculture sector, ornamental fish breeding, culture, and trade offer fantastic job and income opportunities. Furthermore, it is both environmentally and socially acceptable industry. (Wijesekara & Yakupitiyage, 2001).

The ornamental fish production in Sri Lanka has originated with a household-based small-scale industry which has a long history. In 1930s, there were several small-scale importers, breeders, and hobbyists in the country. Commercial aquariums have been established at first in 1952 in Colombo. It has now developed into a thriving industry with an export market, affording profit and employment opportunities to many people (Kuruppu, 1998). The large-scale growers have started to move in to rural areas of the dry zone of the country due to overcrowding, high labor costs, and lack of land for fish outgrowing facilities in urban areas. Currently, the ornamental fish outgrowing systems have expanded to the Northcentral, North-western, and Central provinces of the country (Weerakoon, 1997). Ornamental fisheries in Sri Lanka have a good potential due to an enormous geographical conditions, extensive species diversity, and intensive research and development efforts that are already put in by the associated institutions.

The aquarium fish sector in Sri Lanka has become a valuable foreign exchange earner during recent years (Heenatigala, 2007). Ornamental fish export contribution of Sri Lanka was 2% for the world market (SLEDB, 2019). Foreign exchange earning value of ornamental fish in Sri Lanka was grown noticeably since 2018 (Table 1).

Table1. Foreign exchange earning values of ornamental fish in (US$Mn)

Year	Value(US$Mn)
2016	13
2017	15
2018	16
2019	16

Source: Sri Lanka Export Development Board, 2019

Production process of ornamental fish in Sri Lanka

Wijesekara & Yakupitiyage, (2001) have mentioned that, the ornamental fish production sector comprises of different categories as; fish breeders, fish growers, out growers, middlemen, collectors and exporters.

However, in Sri Lankan context, it is difficult to find out fish breeders and growers separately, because there are performing both activities together in their farms. Therefore, generally both of two categories are known as ornamental fish farmers. They are vital part of the ornamental fish industry value chain because of supplying fish either direct or indirect to the market. In Sri Lanka, in the year 2020, the National Aquaculture Development Authority (NAQDA) of Sri Lanka has categorized the ornamental fish farmers based on their production capacity per month. Those categories are;

- III group -small scale farms (Monthly production< 833 fish)
- V group (Monthly production 833-8333 fish)
- IX group (Monthly production 8333-83333)
- VI group (Monthly production > 83333)

Production capacity was estimated by considering the number and sizes of the tanks and also mud ponds availability in the farm. There are two major types of fish cultural systems in ornamental fish farms. They are large outdoor mud ponds and indoor/outdoor cement tanks and also use the glass tanks for the breeding purpose. The method of culture is depend on the variety of fish. Usually varieties such as Angel fish, Carp and Gold fish are raised in mud ponds and Guppies, Mollies, Swordtails and platys in cement tanks (Agri Farming, 2020).

When consider the Corona Virus, the first instance of this virus was reported on December 31, 2019, in Wuhan City, Hubei Province, China. It has linked to Wuhan's Huanan seafood wholesale market. On March 11, 2020, the World Health Organization (WHO) announced the outbreak COVID-19 (Demirci et al., 2020). At present, the virus has spread to almost all countries, leading to millions of cases and thousands of deaths. Most of the countries have implemented social distancing measures and more stringent lockdowns, in order to slow the spread of the virus (Bennett,et al., 2020). Senten,et al (2020) has reported that the corona virus (COVID-19 pandemic) has disrupted the lives and livelihoods of everyone on our planet.

Coping and adaptive measures are represented early

responses during the first five months of the COVID-19 pandemic. While short-term coping will remain important as the pandemic spreads and possibly re-emerges in countries, actors, and institutions relevant sector can carry adaptive responses forward and engage in a process of learning and building strength to prevent future shocks (Love, et al., 2020).Coping strategies mean that the ability to build the capacity for learning and adaptation. Adaptive management is a method of managing complex socio-ecological systems based on incremental, iterative, experiential learning and decision making, backed up by active monitoring of decision outcomes and feedback from their consequences (Milestad et al., 2008).According to Mensah and Merkuryev (2014), "resilience" is defined as a substance's ability to return to its former state after being deformed. Following COVID-19, efforts to promote resilience should evaluate resilience against what, for whom, and for what purpose. And also be aware of the potential for these decisions to have a cascading effect (Love, et al., 2020).

As the pandemic shifts and possibly re-emerges in countries, there is a continuing need for coping responses to maintain the sector's core functions and protect vulnerable populations working in or dependent. And also coping responses contribute the adapting the difficult situations. A key transition point for actors will be knowing when to shift from short-term coping strategies to the development and implementation of longer-term adaptation strategies and resilience-building .it is necessary to prevent future tremors and respond to ongoing stressors. These shifts will be staggered in time as the pandemic progresses through countries and regions of the world. An additional consideration is how specialized adaptations should be, because increasing resilience to future pandemics may reduce general resilience to an unknown.

According to that, the COVID-19 pandemic has influenced by different perspectives on the different kind of sectors because their impacts are varied. When ornamental fish production is concerned, it is not the same as other sectors, because it is dealing with live beings. Therefore, the overall objective of this research was to study the impact of COVID-19 pandemic on ornamental fish production from the farmers' viewpoint. Moreover, some specific objectives of the study were to find the present situation of ornamental fish production in Colombo district, including coping strategies and resilience methods that farmers have being using for adapting pandemic situation, and also to highlight the farmers' constraints during the COVID-19 pandemic and suggest the solutions for those main constraints of the ornamental fish farmers during the COVID -19 pandemic period.

MATERIALS AND METHODS

Colombo district was purposely selected for the study, due to most of the ornamental fish farms are there. Main ornamental fish farming activities such as breeding, grow-out, and export activities are conducting around the Colombo district (Wijesekara & Yakupitiyage, 2001). Then, four DS divisions were selected based on the records of the National Aquaculture Development Authority (NAQDA),that were having higher numbers of ornamental fish farmers. They were Padukka, Seethawaka, Kesbewa, and Kaduwela DS divisions. As there were only 60 ornamental fish farmers in these four DS divisions, data was collected from all of them. Primary data were obtained using a researcher-administered questionnaire survey from July to October 2020.Closed-ended and open-ended questions were included in the questionnaire and it was pre-tested before using.

The descriptive statistics were used to identify the socio-economic factors of ornamental fish farmers and a two-sample Wilcoxon signed-rank test was used the examined the impact differences before and during the COVID-19 pandemic. Also, the chi-square test was used to identify the association between socio-economic characteristics and coping strategies.

Figure 1. Study area of the research

In this study, ten hypotheses were tested as five hypotheses related to impacts of COVID-19 and the other five hypotheses were related to the association between socio-economic characteristics and coping strategies during COVID-19 pandemic.

Research hypothesis

There was five sets of hypotheses to assess the impact differences before and during COVID-19 pandemic

H_{01} - There is no significant difference between production capacity of farmers before and during COVID-19 pandemic.

H_{02} - There is no significant difference between selling amount of farmers before and during COVID-19 pandemic.

H_{03} - There is no significant difference between cost of production of farmers before and during COVID-19 pandemic.

H_{04} - There is no significant difference between number of fish varieties before and during COVID-19 pandemic
H_{05} - There is no significant difference between number of market opportunities of farmers before and during COVID-19 pandemic.
The other five sets of hypotheses were used to analyze the association between socio-economic characteristics and coping strategies during COVID-19 pandemic.
H_{01}-There is no association between monthly income from ornamental fish farming and coping strategies
H_{02}-There is no association between production capacities of the farms and coping strategies
H_{03}-There is no association between training of farmers and coping strategies
H_{04}-There is no association between experiences of farmers and coping strategies
H_{05}-There is no association between educational levels of farmers and coping strategies
Data Analysis was done by SPSS version 21 and Microsoft Excel Software 2013 package.

RESULTS AND DISCUSSION

General characteristics of the ornamental fish farms

General characteristic of the ornamental fish farms such as cultural activities, size of the farm, nature of production facility, water source, type of labors use in ornamental fish farming and production capacity on the farm were studied in details. The results are shown in table 2.

As per the results in table 2, majority of the cultural activities in the farms were breeding and rearing activities. Wijesekara & Yakupitiyage, (2001) also indicated similar results in their study on "Ornamental fish industry in Sri Lanka: Present status and constraints", the dominant categories were breeding and rearing. The reason behind this result is that, the farmers can obtain financial benefits when conducting both activities in the farm. But it can be varied based on the varieties of ornamental fish. Furthermore, results revealed that, the majority of farm size was less than 20 perches and also a considerable amount of farms have belonged to 20-119 perches category. A few farms have more than 320 perches (2 acres) of land area. These large size farms were mainly situated away from the urban areas. But most of the farms situated close to urban areas are small size farms, due to limited land sizes in urban areas.

While most of farms (30%) have both cement tanks and glass tanks as their production facilities, 27% of farms having only cement tanks. For the rest of the farms (18%) have used all kinds of production facilities. However, Wijesekara & Yakupitiyage, (2001) mentioned that, main farms have only cement tanks.

But based on this result compare to past , more glass tanks are using at present, In the study on "farming ornamental fish" Wills in 2020 has mentioned that, traditionally, most of the Asian production of ornamental fish has been undertaken extensively, using static outdoor ponds or tank systems. However, it varies based on the fish varieties, farmers' capabilities, and size of the farms.

Table 2. General characteristics of ornamental fish farms (n=60)

General characteristics		Percentage (%)
Cultural activities on the farms	Breeding	06.7
	Rearing	08.3
	Out-growing	03.3
	Breeding and Rearing	78.3
Size of the ornamental fish farms	< 20 perches	40.0
	20-119 perches	28.3
	120-219 perches	16.7
	220-319 perches	06.7
	>320 perches	08.3
Nature of production facility on ornamental fish farms	Cement tank	27.0
	Mud ponds	03.0
	Glass tanks	05.0
	Cement tanks and Mud ponds	15.0
	Cement tanks and Glass tanks	30.0
	Mud ponds and Glass tanks	02.0
	All	18.0
Water sources on ornamental fish farms	Well	43.0
	Tap water	27.0
	River water	24.0
	Other	06.0
Type of labor of farms	Family labor	65.0
	Hired	32.0
	Both	03.0
Production capacity on the farm	<833	06.6
	833-8333	46.7
	8333-83333	30.0
	>83333	10.0

When consider the water sources, most of the ornamental fish farms (43%) used wells as the water source. While

27% of farms used tap water, 6% of farms used other water sources such as canals under the natural water channels. The reason behind this result is that, water quality (water PH, Temperature, dissolved gases (Oxygen and Carbon-dioxide), salinity, etc) is a vital factor for production of ornamental fish. It was also mentioned by Usha, Sharath, & Prashant, (2013) on their study of "Study on ornamental fish diversity and water quality of Adda Hole stream, Kabbinale forest range, Western Ghats". Also, most of the farmers have mentioned that, when use tap water as the water source, it is badly affected for the fish production. There were some water quality problems such as chlorine content, etc. But some farmers used tap water under special management practices. 24% of the farms used river water as the water source, especially for the mud ponds.

With regard to type of labour, 65% of the farms in this area used family laborers. Also, 32% of farms used hired laborers and only 3% of farms use both labour sources. Hired labour is very costly and it increases the cost of production. Production capacity is determined based on the NAQDA production capacity categorization procedure. According to that, majority (46.7%) of the farms belonged to the 833-8333 per month production category or V group. While 30% of the farms were belonging to the 8333-83333 category or IX group), 6.6% of farms belonged to less than 833 production capacity per month. However, there was not the high production capacity as these farmers didn't have facilities to reach to that level. .

Demographic characteristics of the farmers

Demographic characteristics of the farmers were studies and the results are presented in table 3.

As shown in Table 2, out of the respondents, the majority of the ornamental fish farmers were male and a minimum of them represented female. In Sri Lanka, there were more men involved in ornamental fish production. But a small number of females were also engaged in farming because they are looking forward to an additional income generation path at the household level. The age distribution of the sample highlighted that majority of the ornamental fish farmers belonged to the 28-47 years category. The second largest group accounted for the 48-67 age category in the study area and there were not a considerable amount of farmers under the less than 28 age category.

The result revealed that most of the younger generation was not engaged in ornamental fish production. Dominantly mid-age category people had involved for farming and they have more experience regarding this field. According to the educational background of the sample, the majority (53%) of the respondents have studied up to the advanced level (A/L) and around 22 % had studied up to the ordinary level (O/L).

Table 3. Demographic characteristics of the ornamental farmers (n=60)

Demographic characteristics		Percentage (%)
Gender	Male	81.7
	Female	18.3
Age	<28 years	06.7
	28-47 years	28.0
	48-67 years	21.0
	>68 years	07.0
Education level	No formal education	20.0
	Below grade 5	03.0
	Up to O/L	22.0
	Up to A/L	53.0
	Degree and above	20.0
Income of ornamental fish farmers (LKR)	<25000	14.0
	25000-50000	14.0
	50000-75000	14.0
	75000-100000	18.0
	>100000	40.0
Experience of ornamental fish farmers	Less than 1 year	05.0
	1-5 years	33.3
	5-10 years	23.3
	More than 10 years	38.3
Training on ornamental fish farmers	Not training	49.0
	NARA	08.0
	NAQDA	25.0
	Other institute	18.0
Farming status on ornamental fish farmers	Full time	60.0
	Part time	40.0

Only 2% of the farmers were degrees and above. 3% of farmers didn't have formal education. Wijesekara & Yakupitiyage, (2001) also indicated similar results in their study "A study of the constraints affecting ornamental fish production in Sri Lanka". Most of the ornamental fish farmers belonged to the more than 100000 LKR category and the second majority of respondents were in the 75000-100000LKR category. 14% of farmers belonged to the less than 25000LKR category. The result revealed that ornamental fish farming is a productive field for in-

come generation if it is conducting the correct manner. Farmers' income varies according to their production of fish varieties and their target market. While the majority of farmers had more than 10 years of experience in the field, there was a noticeable amount of farmers having 1 to 5 years of experience. Only a few farmers were less than 1-year of experience and they were newcomers to the field. According to the result, a considerable amount of farmers had functioned on their farms for more than 10 years and now they have in a stable position. While 49% of the ornamental fish farmers didn't have formal training on ornamental fish, 51 % had undergone training at different institutes including the National Aquatic Resources Research and Development Agency (NARA), National Aquaculture Development Authority (NAQDA), and other institutes. Of these, only 25% of the studied population had been trained at Rambadagalla's three days training program which is conducted by National Aquaculture Development Authority (NAQDA). Wijesekara & Yakupitiyage, (2001) mentioned that the majority of farmers didn't have formal training on ornamental fish production but in the present, it varied because most of the farmers have interested in the training programs to develop their knowledge and skills for conducting farm activities in the right manner.

The majority of ornamental fish farmers conducted farms full-time. Less amount of farmers conducted their farms part-time. The majority of farmers have identified that ornamental fish farming is the best path for generating income therefore most of the farmers have engaged to work full time with ornamental fish farming activities.

Positive and Negative impact during COVID-19 pandemic

Positive and negative impacts were analyzed from the identification of the difference between selling amount, production capacity, cost of production, number of fish varieties, and number of market opportunities of ornamental fish farmers before and during the COVID-19 pandemic. The data was not normal distribution which was named as non-parametric data. Therefore two-sample Wilcoxon signed-rank test was used for comparison of those factors' median values before and during the COVID-19 pandemic.

The selling amount was measured by the number of fish that they were selling per month before and during the COVID-19 period. Results indicated (Table 3) that the sum of rank (1501) was a high value regarding the positive rank. According to that during the COVID-19 period selling amount had increased more than before COVID-19. And also test significant value was 0.000 based on the negative rank. Therefore null hypothesis was rejected so that there was a significant difference between before and during the COVID-19 period. There was a noticeably high sales amount when compared with before COVID-19 sales amount per month. According to that, there was good market demand for ornamental fish during the COVID-19 period than before the COVID-19 pandemic. But the main problem of farmers was that couldn't have the ability to fulfill the market requirement because of their low production capacity.

The cost of production per month was measured by using the following equation (Gray, 2001).

Cost of production= fixed cost + variable cost

Under the fixed cost, the cost is calculated basically brood stocks cost, labor cost, and water and electricity cost. The variable cost calculated basically feed cost, Packaging & delivery, medication, traveling overseas, and filter repairs cost. Results revealed that positive rank value was the high sum of rank value; during the COVID-19 period, the cost of production increased more than the earlier cost of production. The significant value was 0.000. It was less than 0.05 value according to the median value was a significant difference. Hence during the COVID-19 period, the cost of production was a significant difference.

Production capacity was measured by the number of fish rearing before and during the COVID-19 pandemic. Negative ranks represented the high sum of rank value (950) which means was during COVID-19 production capacity less than before COVID-19 production capacity per month. Table 3 shows the variation of the positive and negative rank and significant value based on the positive rank. The significant value was 0.000 which was less than the 0.05 value. Therefore median value was significantly different. According to that production capacity was significantly different before and during the COVID-19 period. The reason behind the result, most of the farmers have suspended breeding activities because of feed problems and also a considerable amount of fish died because of disease infection. Disease infections have been noticeably high during the COVID-19 pandemic situation because some farmers have functioned breeding process continuously then they had kept the fish in the tank more than the recommended amount of fish. Hence disease infection and death of fish problems had increased during the pandemic situations.

Current ornamental fish production status

There weren't changes in fish varieties produced by the farmers before and during the COVID-19 period. The negative rank sum of rank value and the positive rank sum of rank value wasn't high differences between them because in both situations farmers' production fish varieties were the same and also significant value was greater than 0.05 values in order to that the null hypothesis was accepted (table 03). Hence median value was not significantly different before and during the COVID-19 period.

Table 4. Positive and negative impact on ornamental fish farmers

Factors			Sum of Rank	Asymp. Sig. (2-tailed)
Selling amount of ornamental fish before and during COVID-19 pandemic	Negative Ranks[a]	269.0	a. During COVID-19 Selling amount per month < Before COVID-19 Selling amount per month	0.000
	Positive Ranks[b]	1501.0	b. During COVID-19 Selling amount per month > Before COVID-19 Selling amount per month	
Production capacity of ornamental fish before and during COVID-19 pandemic	Negative Ranks[a]	950.0	a. During COVID-19 Production capacity per month < Before COVID-19 Production capacity per month	0.000
	Positive Ranks[b]	131.0	b. During COVID-19 Production capacity per month > Before COVID-19 Production capacity per month	
Cost of production before and during COVID-19 pandemic	Negative Ranks[a]	147.50	a. During COVID-19 cost of production per month < Before COVID-19 cost of production pre month	0.000
	Positive Ranks[b]	842.50	b. During COVID-19 cost of production per month > Before COVID-19 cost of production pre month	
Number of fish varieties before and during COVID-19 pandemic	Negative Ranks[a]	80.0	a. During COVID-19 number of fish varieties < before COVID-19 number of fish varieties	0.867
	Positive Ranks[b]	73.0	b. During COVID-19 number of fish varieties > Before COVID-19 number of fish varieties	
Number of Market opportunities for ornamental fish before and during COVID-19 pandemic	Negative Ranks[a]	24.0	a. During COVID-19 Market opportunity < Before COVID-19 Market opportunity	0.171
	Positive Ranks[b]	12.0	b. During COVID-19 Market opportunity > Before COVID-19 Market opportunity	

Table 5. Current ornamental fish production status

Fish variety		Percentage (%)
Angle	*Pterephylum scalare*	15.91
Swordtail	*Poecilia reticulate*	10.61
Carp	*Cyprinus carpio*	10.61
Guppy	*Poecilia reticulate*	9.85
Fighter	*Betta splendens*	9.09
Zibra	*Branch ydanio rerio*	6.82
Discuss	*Svmphpsodon aequjfasciatus*	5.3
Plety	*Xiphophorus maculates*	5.3
Goldfish	*Carassius auratus*	5.3
Molly	*Poecilia sphenops*	5.3
Tetra	*Paracheirodon innesi*	4.55
Oscar	*Astronotus ocellatus*	4.55
Barbe	*Puntigrus tetrazona*	2.27
Gourami	*Trichogaster lalius*	2.27
Flowerhorne	*Paraneetroplus synspilus*	0.76

The ornamental fish farmers didn't have to engage in changing their production of fish varieties during the COVID-19 period because they didn't have market problems for selling their products. The current status of production of ornamental fish varieties in the study area was shown in table 04. According to the results, in the study area Angle varieties were dominantly produced on the farms. And also sword-tail, Carp, Guppy, and Fighters varieties have been produced in considerable amounts. Those five varieties have high production capacity within the studied area. Malawi, Catfish, and Flower hone varieties have a low production capacity in the studied area.

Current market opportunities of ornamental fish farmers

The market opportunity was measured by the number of the target market of farmers that was going to sell their fish. Table 3 represented the sum of rank values before and during the COVID-19 period. The result revealed that the sum of rank variance was not considerably changed during the COVID-19 period. And also test statistic's significant value was greater than the 0.05 value. Hence farmers' market opportunities were not significantly different before and during the COVID-19 period. Based on the study, farmers had sold their production for supply exporters, local market, both local market and direct exporters, both local market and supply exporters at the present. In fact, Wijesekara & Yakupitiyage, (2001) mentioned that most of the farmers sold their products to the supply exporters in his study. Based on that majority of farmers (35%) had sold products to the supply exporters and 31.7% of farmers sold for the local market (table 5)

Table 6. Current market opportunities of ornamental fish farmers

Market opportunity	Percentage(%)
Local market	31.7
Supply Exporters	35
Local and Supply exporters	21.7
Local and Direct export	6.7

The reason behind the results, the export market has a considerably high demand than the local market. Therefore most of the farmers have been engaged in selling their products to the supply exporters, and also supply exporters have paid high prices than the local market. But the supply exporters were mainly concerned about the fish quality when purchasing the farmers' products. Hence most of the time farmers' products have been rejected due to quality problems. According to that, the COVID-19 pandemic didn't have an effect on changing the market opportunity of the farmers.

Problems of ornamental fish farmers during the COVID-19 pandemic

Problems of ornamental fish farmers were categorized into three parts as production problems, market problems, and other problems that they had to face during the COVID-19 pandemic and presented in three sections in below.

The result revealed (Table 6) that 87.7% of farmers were faced with the problem of receiving fish feed and additives. As most of the fish feed imports to Sri Lanka, farmers have difficulty accessing the feed during COVID- 19 period due to COVID-19 adversely affected for the import and export market. Therefore it is directly affected maintaining the fish quality. The second major production problem is the death of fish. The main reason was that most of the farms were situated in a limited area and farm activities function during the lockdown period with the continued breeding process. Hence they had to face space problems on the farm. As a result, they had stocked exceeded fish amount rather than recommended level which adversely affected the fish died. The percentage of other production problems was shown (table 6) based on the priority of the problems. The cleaning problem within the farms was low percentage because most of the farms didn't hire the laborers as they function their work with family members.

Those production problems have varied based on the farm category (table.7). Based on the V group (833-8333) and the IX group (8333-83333) category farms dominantly have to face production problems during the COVID-19 period. As they have maintained their activities within a limited land area, haven't the adequate land area to function for farm activities. Hence they had to face production problems rather than other groups of III group (833)and VI group (> 83333) of farms.

The III group of farms had a minor influence on the production problems due to their production capacity being low level. Their production problems influence had a minimum level when compared with other groups. VI group category farms also had a minor influence on the production problems because they have sufficient income levels rather to other groups of farms.

Table 7. Problems of ornamental fish farmers

Problems of ornamental fish farmers		Percentage (%)
Production problems	Problem of receiving feed and additives	87.7
	Death of fish	80.7
	Problem of maintain quality	78.9
	Difficult to function natural and artificial breeding activity properly	77.2
	Difficult to find quality breeding fish	61.4
	Problem of receiving medicine	35.1
	Disease infection	31.6
	Cleaning problems in farm	22.8
Market problems	Problem of transport facility	98.2
	No stable price	34.5
	Lack of buyers	34.5
	Reject the stock due to the weight problem	32.7
	Lack of collecting by sellers	27.3
Other problems	Lack of involvement of government and other responsible organization	96.6
	Lack of loan facilities	86.2
	Lack of insurance facilities	72.4
	Labor problem	25.9
	Difficult to recover the loan	25.9

Within the marketing problems, the majority 98.2% of farmers had problems with transport facilities. During the COVID-19 pandemic, the government had put travel restrictions between the districts. In Sri Lanka police issued the travel pass for the essential services. But ornamental fish farmers couldn't have access to the pass due to the responsible persons had less awareness about the ornamental fish industry. Therefore the majority of

the farmers couldn't obtain the feed and other facilities during the COVD-19 period due to the problem of transport facilities. Table 6 shows, other market problems based on prioritization. The 34.5% percentage of farmers had the problem of stable prices and lack of buyers. 32.7% of farmers had faced the problem of rejecting the stock due to the weight problem. When exporting the products, flight charges are calculated based on the weight of the packing box. Weigh of the ornamental fish packages have low when compared with the other packages' weight. Hence most of the packages were rejected during the COVID-19 period due to the limited flight facilities. Table 7 indicated the farmers' market problems impact based on the production capacity on the farm. According to that V group (833-8333) and the IX group (8333-83333) category farms dominantly faced market problems rather than other farms' categories.

Table 8. The problems percentage with the farm groups

		<833	833-8333	8333-83333	83333<
Production problems	Frequency	4.0	25.0	18.0	6.0
	Percentage (%)	7.5	47.2	34.0	11.3
Market problems	Frequency	4.0	22.0	18.0	6.0
	Percentage (%)	8.0	44.0	36.0	12.0

Table 6 indicated under the other problems category that 96.6% of farmers had a problem of lack of involvement of government and other responsible organizations. And also 86.2% of farmers couldn't access loan facilities due to the lack of loan facilities allocating ornamental fish industry. There was a low percentage of the problem of labor and recovery of the loan facilities. The majority of the farms worked with family labor and some farms' laborers stayed in the house. Therefore there was a noticeably low level of labor problems during the COVID-19 period.

Coping strategies and Resilience methods of ornamental fish farmers during COVID-19 pandemic

Most of the farmers (58.3%) had used special coping strategies during the COVID-19 pandemic for responding to the COVID-19 outbreak. However, 41.7% of farmers were not engaged to use coping strategies during the COVID-19 pandemic. As indicated (Figure 2) 44.4% of farmers had engaged to reduce the frequency of fish feeding due to the feed problems during the COVID-19 pandemic. And also 34.9% of farmers had used the method of suspending the breeding activities due to the problem of receiving feed and the problem of space in the tanks. Based on the results, farmers had used the same feed for each stage, they didn't function sorting process and used alternative feed instead of fish feed during the COVID-19 pandemic situation as the adaptation strategies. SAARC Agriculture Centre (SAC), (2017) mentioned that mainly farmers should be concerned about the feed management process. feed process is differed based on the fish stages such as nursery stage, and growth stage, and also feed should be supplied at the right time and required amount. In fact, the farmers had shifted from the actual management practices to engaging the coping strategies.

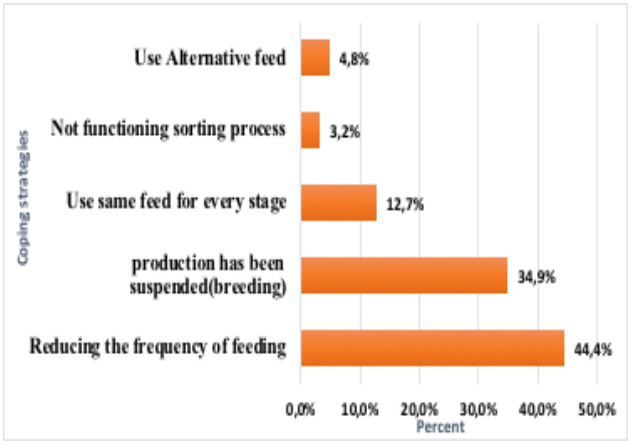

Figure 2. Coping strategies of ornamental fish farmers

Within the study area,46.7% of farmers have used resilience methods for getting back to their original state. But 53.3% of farmers didn't use resilience methods. The reason for the result, the market demand for ornamental fish had noticeably increased during the COVID-19 pandemic, therefore, most farmers had the ability to continue their farming activities without using resilient methods. Among the farmers engaging in using resilience methods, 36.4% of farmers have hoped to gain financial support for getting back to the original stage. 29.5% of the farmers wished to engage in the changing of fish varieties based on the market demand because market demand varies according to the fish varieties.

Analyze the association between socio-economic characteristics and coping strategies

The education level of the farmers, experience of farmers, training on farmers, monthly income of the farmers, and production capacity of the farms was used as the socio-economic characteristics. The relationships were measured using the chi-square test. The coping strategies were used as the dependent variable. According to the results of table 8, there was a significant association between the monthly income of farmers and using coping strategies,$x2$ (4, N=57)=33.03,p=0.000. and also, there was a significant association between the production capacity per month and use of coping strategies,$x2$ (3, N=56)=16.686,p=0.001, Socio-economic characteristics of the education level of farmers, the experience of farmers and training of the farmers were not a significant association with the using of coping strategies because there was significant value was greater than 0.05 value.

Table 08 explained that the association between the coping strategies and production capacity on the farm.

Low production capacity farms (<833) were dominantly engaged in using coping strategies during the COVID-19 period. Large production capacity farms (>83333) were not engaged in using coping strategies. Low production capacity farms had more problems rather than large production capacity farms because of they didn't have sufficient income levels to maintain the farming activities. As a result, they had to use coping strategies for adapting to the pandemic situation. And also more than 100000 LKR income category farms were not engaged in using coping strategies during the COVID-19 period because they had adequate facilities to maintain their farms. But other income category farms had to follow coping strategies for adapting to the critical situation.

Table 9. Relationship between coping strategies and socio-economic characteristics

socio-economic characteristics	df	Asymp. Sig. (2-sided)
Education level of farmers	4	0.771
Experience of farmers	3	0.201
Training of farmers	3	0.768
Monthly income from ornamental fish production	4	0.000
Production capacity of the farm	3	0.001

The current main constraints of ornamental fish farmers besides the impact of the COVID- 19 pandemic

Ornamental fish farmers already have constraints besides the impact of the COVID-19 pandemic. The current main constraints of ornamental fish farmers besides the COVID- 19 impact were assessed using 10 statements along 5 points Likert scale as Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. Based on table 9, there were very high mean values (>4) for five statements. Those high mean values indicated that farmers strongly agree with those five statements namely; Lack of market information about the changes in the overseas demand, Low price given for the product, and lack of communication between farmers.

Farmers have mainly ridden with this constraint besides the COVID-19 pandemic due to the poor information linkage between the farmer and the buyers. Therefore farmers don't have updated knowledge about the market demand of the fish varieties. Hence they produced the same fish varieties without any idea of the market demand then they couldn't sell their products due to the surplus of the market regarding the same fish varieties. As a result, they have engaged to suspend their production process and give up the farming process. This study has suggested the "Ideal "ORNAFISBIZ" Model (figure 3) for avoiding the major constraint of the farmers (Devi,et al., 2017). The ideal model is shown below which is also beneficial for developing the farmers' production. And also the model helps to avoid ornamental fish farmers' barriers as well.

This model is only suggested for the information linkage between the farmers and buyers as a solution for avoiding the major constraints. At the initial stage, farmers' production process should be prepared in a productive way because farmers when linked with the market could supply quality fish for both domestic and export markets. If they couldn't supply quality fish, buyers could be refused the purchasing their products. This model is vital to both markets because they could determine and select the farmers based on their product quality and their supply capacity.

In this model, at the beginning farmers' production category is divided into three parts. There are pre-production, production, and post-production. The pre-production stage should be facilitated mainly by training and knowledge to keep the production process and facilitate the infrastructure and loan facilities to enhance their production capacity. During the production process, supply the diagnostic services, access to modern improved technology facilities, and monitoring the process. At the post-production, stage farmers should be graded based on the fish quality and quantity and issued the certificate to them for further identification. It is a pivot part of the information linkage model because the buyers can easily identify the nature of the farmers' production before purchasing. And also farmers could be selected the buyers based on their production capacity, and quality, and they could be functioned and manage their production process based on the market demand.

The second step was all the farmers' linkage together as the district wise through the district society of ornamental fish farmers. It helps to follow the information toward the farmers because there isn't a high population of ornamental fish farmers therefore should be built up the relationship among them to follow the information. If most of the farmers have engaged to produce the same varieties without interconnection with them, it could be caused to deduct the market demand regarding those varieties.

In the last stage district society of ornamental fish, farmers should be connected with the district collector centers which is the place to coordinate both parties by providing information to both sides. The collector center has linked both parties forwardly and backwardly. This is the

Table 10: Constraints of ornamental fish farmers

Serial No	Statement	Mean	Std. Deviation	Remark
01	Lack of market information about the changes in the overseas demand	4.60	0.764	Strongly Agree
02	Low price given for the product	4.53	0.769	Strongly Agree
03	Lack of communication between farmers and buyers	4.28	0.804	Strongly Agree
04	Delays and non-payments for products	2.92	0.809	Disagree
05	High investment cost	4.53	0.623	Strongly Agree
06	Difficulties in entering export market	2.95	1.141	Disagree
07	Difficulties in finding markets for products	3.05	2.740	Agree
08	Difficulties in maintaining the enterprise in off-season	3.53	0.911	Agree
09	High maintain cost	3.53	0.623	Strongly Agree
10	Export in fish in same cases for prices	3.67	0.752	Agree

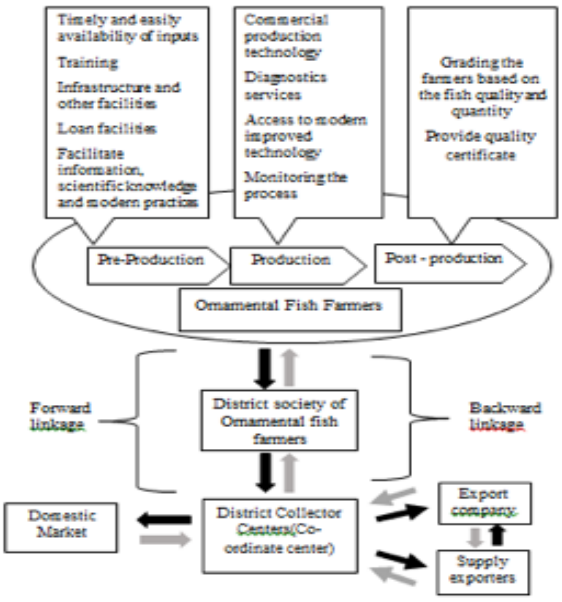

Figure 3. Ideal "ORNAFISBIZ" Model for Sri Lanka to information link between the farmers and Exporters

place where is kept all information about farmers and market information. This is the ideal model to avoid the farmers' major constraints.

CONCLUSION

According to the findings, Most of the ornamental fish farms dominantly conducted breeding and rearing activities together as the cultural activities and the majority of ornamental fish farms belonged to the 8333-83333 per month production category. Male farmers are mainly participating in ornamental fish production and also a higher number of farmers have education levels up to A/L within the study area. The farmers have more than 10 years of experience in the field. So, farmers have a good background on engage in ornamental fish farming. However, most of the farmers didn't have to get any formal training regarding ornamental fish production. Apart from that majority of farmers have conducted their farming activities as a full-time occupation.

The COVID-19 pandemic has rapidly spread around the world. It has caused negative and positive impacts regarding ornamental fish production in the country. As the major positive impact during the COVID-19 period was, the selling amount of ornamental fish had unexpectedly increased but farmers couldn't have the supply market requirements due to the low production capacity. Major negative impacts during the COVID-19 period, farmers' ornamental fish production capacity decreased during the COVID-19 period due to the main production problems. The cost of production for farmers' had increased during the COVID-19 period compared with the before COVID-19 period due to the increase in feed price (mainly Brine shrimp price). Fish verities produced by the Farmers didn't change during the COVID-19 period. Most of the farmers produce the same fish varieties before and during the COVID-19 period. In the study area, most of the farmers had dominantly produced Angle, Swordtail, Carp, Guppy, and Fighters. Farmers' market opportunities hadn't changed during the COVID-19 period because they sold their production same target market during the COVID-19 period. Dominantly farmers sell products to the supply exporters who are the person connected with the direct exporters.

Farmers suffered from production, market, and other problems during the COVID-19 period. Among them, the problem of receiving feed and additives and died of ornamental fish were the main production problems of the farmers. Under the marketing problems were difficulties in transport facilities and unavailability of a stable price, lack of buyers, reject the stock due to the weight problem, and lack of collecting by sellers. Lack of involvement of government and other responsible organizations and lack of loan facilities were the main problems categorized under the other problems of the farmers.

During the COVID-19 period, most of the farmers have engaged in using coping strategies for responding to the outbreak. Mostly they followed reducing the frequency of feeding strategies, suspended breeding activities, using the same feed for every stage, and used alternative feed respectively during the COVID-19 period. Those coping strategies had been influenced by the reduction of farmers' production capacity and quality of the fish.

There was an association between the income level of the farmers and the production capacity of the farms with the use of coping strategies. The education level of the farmers and experience and training of the farmers didn't show an association with the use of coping strategies. While high-income farmers were not engaged in using coping strategies, low-income farmers had been mostly engaged to follow the coping strategies. Also, high production capacity farms were not engaged to use coping strategies. Although most of the farmers are not hoping to use resilience methods for re-building their production process, few farmers had involved to use resilience methods among them dominantly hoping to obtain financial support for enhancing the production capacity.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original.and that they have not been published before.

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