

EXPLORATION OF SUSTAINABLE LIVE FISH BUSINESS IN NEPAL

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ABSTRACT

Live fish businesses are likely to become more popular in Nepal due to their reliable source of food. The live fish food survey data was collected from a Google Form questionnaire in the Nepalese language. This study investigates consumers, retailers, and wholesalers in Nepal's live fish market to identify significant concerns that could be addressed in the decision-making of live fish professionals. Nonparametric tests are used for non-normally distributed data, and parametric tests are used for normally distributed data. The study found high mortality and administrative obstacles of 68.60% and 48.60%, respectively. If the wrong choice of aeration method and equipment is made, more fish will survive in the retailer's shop and during transportation time. Fish Models II and III will be an alternative to the current method of transportation, which shows that increasing the tank capacity by one standard deviation increases fish survival by 0.7 and 0.65 standard deviations, respectively. To increase the dissolved gas, the survey suggests that transportation and aeration methods should be improved. This increases the volume of transportation while using the same resources, meeting market demands

1. INTRODUCTION

Nepal's abundant water resources make aquaculture promising. Nepal has 200 species of fish, 190 of which are native, and the rest are exotic. Nepal's piscatorial industry is vital to its economy. Aquaculture in Nepal is an emerging industry that has shown immense potential to contribute significantly to the country's economic growth and food security. Nepal is blessed with abundant aquatic resources that cover approximately 5.5% of the total land area, but only 2% of the estimated 826,818-hectare water surface area is used for aquaculture and capture fisheries. This industry provides jobs, food security, resource conservation, and foreign currency. Aquaculture accounts for 0.44% of Nepal's GDP and 1.83% of its agricultural GDP (CFPCC,2022).The Nepalese fishery sector provides employment opportunities for the large population of Nepal (Gurung, 2016). Artisanal fishing supplies more than 70% of Nepal's fish demand. Many Nepalese eat live fish as their main food source. Nepal needs a sustainable aquaculture industry. Understanding the national live fish market is crucial. Nepal began commercial fish farming in 1947 (Rai *et al.*, 2008). The

Terai region now leads commercial carp production. Improving fish production: Nepal needs more fish. The piscatorial industry in Nepal employs a large portion of the population, reducing poverty and boosting the economy. Fisheries production in Nepal can boost food security and the economy. Furthermore, aquaculture growth has positively contributed to global food and nutrition security by mitigating reductions in fish production from capture fisheries to meet the increasing demand for fish. Minor and major 1947 producers are joining carp farming, proving its success. Due to its abundant water and rich soil, the Terai region of Nepal is ideal for carp farming. Water management in Terai's lowlands allows fish farming and productivity. Gurung (2003) stated that *Aristichthys nobilis* (bighead), *Cyprinus carpio* (common carp), *Labeo rohita* (rohu), and *Catla catla* (Bhukur) thrive in aquatic environments. Carp aquaculture, a lucrative and efficient alternative to conventional agriculture, has given residents of these regions many ways to make money. Kent (1997), Madeley (1981), and Rahman & Islam (2020) point out that sufficient supply of fish market demand boosts the

country's GDP. Due to little knowledge of production and supply, fish culture and consumption declined in Nepal during the 1980s (Madeley, 1981). Recently, healthy people have preferred fish (Ruffle *et al.*, 2019). Fish is essential to a healthy diet (Carlucci *et al.*, 2015; Rahman & Islam, 2020). Ahmed and Azra (2022) report that health-conscious consumers are eating more live fish. Ahmed and Azra (2022) mentioned that the live fish trade is profitable.

The Nepalese live fish market has other problems in addition to its demand-based distribution network. The trade in live fish, especially in rural areas, employs skilled and unskilled workers. Nepal imports 75% of its aquaculture products, mostly from India. Freezing, vacuum packaging, or ice storage preserve these products. This situation threatens Nepal's economy and food security. The Nepalese government is encouraging domestic aquaculture production to address this problem. Additionally, sustainable methods must be implemented to reduce the ecological footprint and ensure Nepal's long-term viability. Nepal can become self-sufficient with sustained investment and innovation. This study examined how Nepalese buyers, sellers, and retailers worked together to address live fish trade and consumption issues. This study should help stakeholders decide on live fish transport, animal welfare, and sales strategies. Researchers examined government policies, local governance, and other

stakeholders to identify gaps that could be filled to improve the welfare of fish market animals. It may also influence local and national food and nutrition policies. This article analyzes consumers and their preferences, suppliers, and consumer issues. The study begins with consumers' perceptions and behaviors when buying fish from markets, then moves on to suppliers and their methods. The final section evaluates the fish market.

2. MATERIALS AND METHOD

2.1. Survey site and data collection

The regions of Bharatpur and Ratnanagar, located in the Chitwan Valley, and Kathmandu and Lalitpur, located in the Kathmandu Valley, were selected based on their potential for the trade of live fish. The National Live Fish Traders Association (NLFTA) and the Central Fisheries Promotion and Conservation Center (CFPCC) in Balaju, Kathmandu, gave a list of live fish stores and suppliers at the study sites, as shown in Figure 1. The fish shop and supplies are chosen at random. Using a Google form, information was collected from face-to-face interviews, direct observations, and focus group discussion. We used supplier and retailer focus group discussions with the participatory method to gather information in the Kathmandu Valley and the Chitwan Valley. The fish shop provided information on customers who bought fish in the second month of 2022.

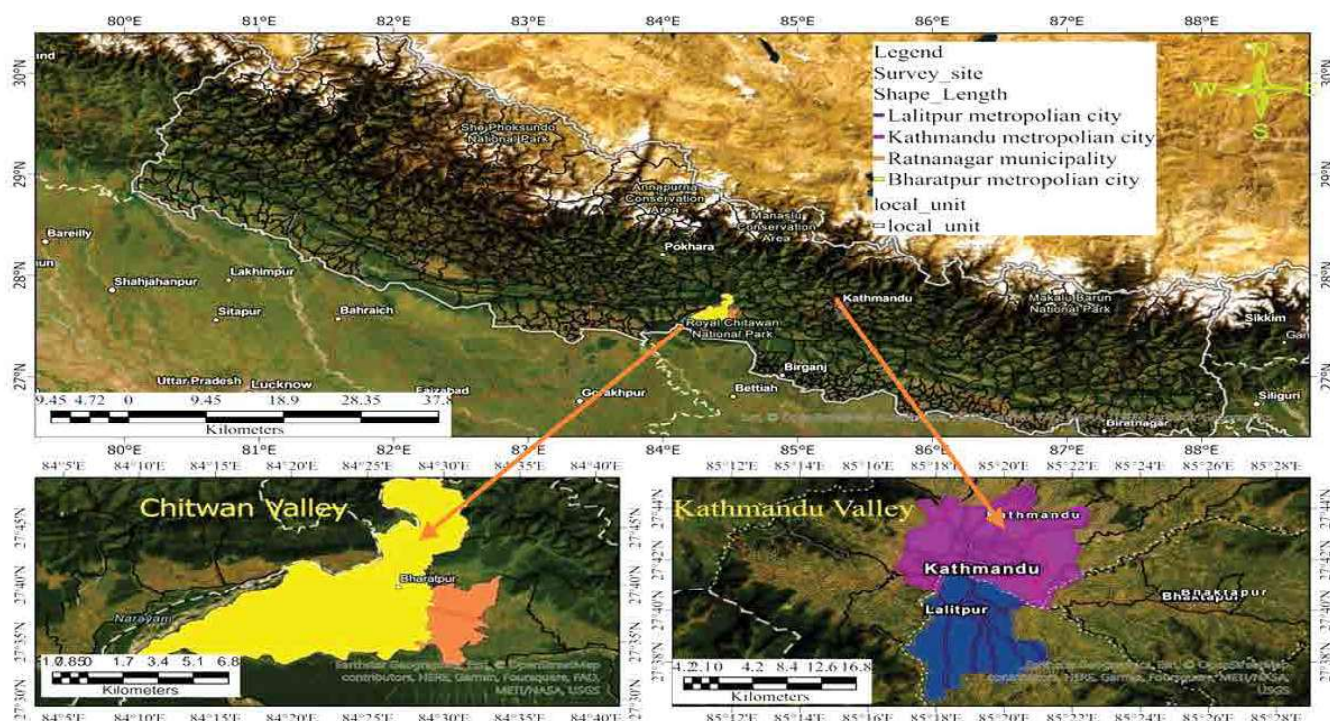


Figure 1. The study areas shown on the map in different colors

2.2. Processing of the response

Socioeconomic status, demographic trends, market conditions, consumer preferences, and marketing problems were recorded. Respondents in Chitwan and Kathmandu were sampled using a simple sampling method. The sample includes 500 consumers, suppliers, and retailers. Unfamiliar fish species and non-consumers were removed from the 407 responses. The analysis includes only 300 valid responses from consumers.

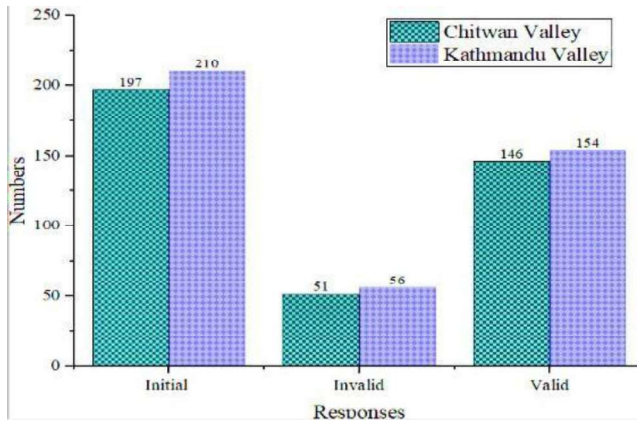


Figure 2. Processing of Consumer Response

2.3 Data analysis

The self-administered Google Forms questionnaires collected data on the building and content of relationships. Multiple choice and multiple response questions are well-designed questionnaires in native language (Annex 1). Before conducting the final survey, pre testing of the questionnaire was done by filling out the questionnaire form and taking 10% of the respondents. In the pilot study, Cronbach's alpha was calculated, which was 0.69. The questionnaire was modified according to the pretesting result of Cronbach's alpha. The information was entered into Microsoft Excel 2016, and the Excel data was edited and cross validated before being imported into SPSS version 25. The statistical methods employed for data analysis and interpretation were descriptive and inferential tools and techniques. The normality testing was done by the Kolmogorov-Smirnov test as the sample size was greater than 50 for applying a suitable parametric statistical method. The association between categorical variables was tested by the chi-square test. The interpretation and presentation of data were based on inferential statistics. The preference of fish species and problems ranking of live fish transportation were assigned by mean rank with Kruskal Wallis test.

2.4. Regression analysis

Regression analysis as part of the investigation, a multiple linear regression equation (Equation i) was made to explain the things that affect how people think about live fish and how they are used on the market. To perform an analysis of the relationships that exist between the dependent variables, consumer perception, and independent variables, the multiple linear regression equation (i) is used.

A population model for a multiple linear regression model that relates a y variable to k x variables

is written as

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k + e \dots (i)$$

Where,

Y is the dependent variable.

X is the independent variable.

K is the number of independent variables.

β is the constant, and the subsequent $\beta_1, \beta_2, \dots, \beta_n$ are the regression coefficients corresponding to the variables X_1, X_2, \dots, X_k . and e are the error terms.

"k" for predictor variables means k+1 regression parameters (coefficients).

However, the multiple regression model used is represented by regression line (i), and the inclusion of significant variables and exclusion of no significant variables criteria were used to fit the predicting equation of the four types of regression models.

2.5. Consumer perception

The questionnaire asks questions about age, sex, level of education, income, employment, and location, among others. Consumer preferences for fish preparation methods and the value placed on fresh, live fish were also considered. Simple descriptive statistics such as mean, maximum frequency, minimum frequency, and percent were used to look at live fish.

2.6. Socioeconomic and business status

Simple descriptive statistics such as mean, maximum frequency, minimum frequency, and percent were used to look at things such as the size of the families of the respondents, how much fish they ate, their work history, etc.

2.7. Profitability analysis

The discounted cost of production and the discounted gross return of the fish industry were used to calculate the benefit-cost ratio using the formula given below.

2.7.1 BC ratio

The discounted cost of production and the discounted gross return from fish farming were used to calculate the benefit-cost ratio using the formula given below (Gahatraj & Subedi, 2020). The purpose of this report is to analyze the financial health of a business. The BC ratio is a financial indicator that serves as a measure of a professional's revenue-generating potential relative to its expenses. Handling is involved in the calculations.

$$BC \text{ ratio} = \frac{\text{Discounted gross return}}{\text{Discounted cost of live fish handling}}$$

2.7.2. Producer's Share ratio

This unique farmer-owned label, also known as the Agri Share Ratio, has deeper implications for farmers and their communities in terms of who supplies the products and who captures the profits (Wijaya *et al.*,

2022). The percentage of the consumer-paid price that the producers receive is known as the producer's share. It was calculated using the following formula:

$$\text{Producer share ratio} = \frac{\text{Retailer price}}{\text{Discounted cost of farm gate price}}$$

3. RESULTS AND DISCUSSION

3.1. Value and supply chain of the live fish market in nepal

Many Terai farmers raise fish for home delivery in this supply chain. The fish farmers in the Terai region breed and raise the fish middlemen, transport them to Nepalese cities, and deliver them on time. Pond-based aquaculture raises fish. Traders and processors prepare fish for shipping. Wholesalers and retailers buy fish from carriers on the market. Manufacturers, retailers, and retailers affect purchases. The distribution of live fish is complicated. Terai farmers supply Chitwan and Kathmandu wholesalers and retailers. Chitwan shops send small, live fish to Kathmandu. Nepal's aquaculture industry is now complex.

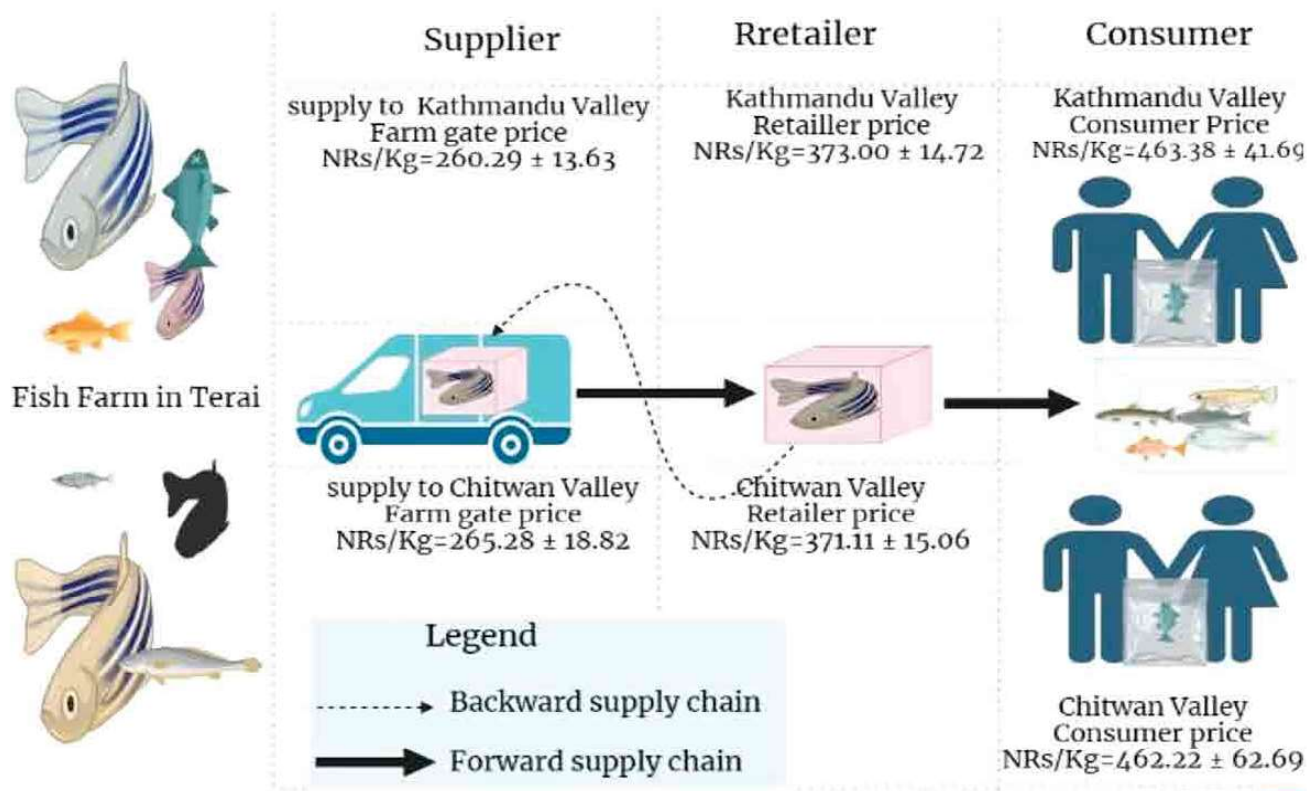


Figure 3. Status of the supply and value chain of the live fish marketing system in Nepal

3.2. Consumer behavior on live fish consumption

Table 1. Perception of the consumer about the consumption of different species of fish according to different factors (Kruskal-Willi test), n=300

Fish species	Consumer group	n	Rank	p(0.05%)
Rohu (<i>Labeo rohita</i>)	Diet	224	157.34	0.01*
	Health	76	130.34	
Rohu (<i>Labeo rohita</i>)	Dead	137	165.31	0.000***
	Live	163	138.06	
Rohu (<i>Labeo rohita</i>)	Chitwan Con.	146	160.11	0.03*
	Kathmandu, Con.	154	141.39	
Rohu (<i>Labeo rohita</i>)	Buy dead also	137	165.31	0.000***
	Return w/o buy	163	138.06	
Trout (<i>Oncorhynchus mykiss</i>)	Chitwan Con.	146	140.42	0.02*
	Kathmandu, Con.	154	160.05	
Silver (<i>Hypophthalmichthys molitrix</i>)	Killing Method	139	144.4	0.01*
	preservative	161	155.77	
Silver (<i>Hypophthalmichthys molitrix</i>)	Dead	137	145.57	0.05*
	Live	163	154.64	
Silver (<i>Hypophthalmichthys molitrix</i>)	Buy Dead also	137	145.57	0.05*
	Return w/o buy	163	154.64	
Naini (<i>Cirrhinus cirrhosis</i>)	Killing Method	139	147.08	0.03*
	Preservative	161	153.45	
Naini (<i>Cirrhinus cirrhosis</i>)	Freshness	197	152.85	0.03*
	Price	103	146	
Common (<i>Cyprinus carpio</i>)	Nonemployee	121	138.71	0.01*
	Employee	179	158.47	
Rohu (<i>Labeo rohita</i>)	Nonemployee	121	131.83	<.001***
	Employee	179	163.12	
Grass (<i>Ctenopharyngodon Idella</i>)	Nonemployee	121	162.53	<.001***
	Employee	179	142.37	
Pangas (<i>Pangasius hypothalamus</i>)	Nonemployee	121	170.17	<.001***
	Employee	179	137.2	
Common (<i>Cyprinus carpio</i>)	Literacy	47	130.67	0.02*
	School	147	147.56	
	University	106	163.37	
Grass (<i>Ctenopharyngodon Idella</i>)	Literacy	47	165.22	0.01*
	School	147	151.81	
	University	106	142.16	
Pangas (<i>Pangasius hypothalamus</i>)	Literacy	47	165.61	0.03*
	School	147	151.93	
	University	106	141.82	

Significant at 0.05; ** Significant at 0.01;*** Significant at 0.001

Table 2. Fish species ranking based on consumer preference (Kruskal-Willi test), n = 300

Preferable fish species	Market	n	Rank	Cases (%)	p (0.05%)
Common (<i>Cyprinus carpio</i>)	Chitwan	108	156.2	70.7	0.161
	Kathmandu	104	145.2		
Rohu (<i>Labeo rohita</i>)	Chitwan	76	159.6	46.3	0.041*
	Kathmandu	63	142		
Trout (<i>Oncorhynchus mykiss</i>)	Chitwan	52	140.8	42.3	0.028*
	Kathmandu	75	159.6		
Pangas (<i>Pangasius hypothalamus</i>)	Chitwan	14	145	13.3	0.07
	Kathmandu	26	155.7		
Grass (<i>Ctenopharyngodon Idella</i>)	Chitwan	13	150	9.3	0.833
	Kathmandu	15	151		
Silver (<i>Hypophthalmichthys molitrix</i>)	Chitwan	13	152.5	7.7	0.414
	Kathmandu	10	148.7		
Bhakur (<i>Catla catla</i>)	Chitwan	7	150.7	4.7	0.898
	Kathmandu	7	150.3		
Naini (<i>Cirrhinus cirrhosis</i>)	Chitwan	3	149.1	3	0.361
	Kathmandu	6	151.8		
Bighead (<i>Hypophthalmichthys nobilis</i>)	Chitwan	4	150.6	2.7	0.924
	Kathmandu	4	150.4		
Total		600		200	

Table 3. Ranking of fish species based on Demographic factors on perception of fish consumption n=300

Description	Groups	Market				X ²	p(0.05%)
		Chitwan		Kathmandu			
		n	%	n	%		
Education level	Literacy	28	9.33	19	6.33	3.9	0.14
	School	73	24.3	74	24.67		
	University	45	15	61	20.33		
Occupation	Nonemployee	51	17	70	23.33	3.5	0.063
	Employee	95	31.7	84	28		
Preferable fish culture region	Hills	118	39.3	112	37.33	2.8	0.098
	Terai	28	9.33	42	14		
Benefits of fish consumption	Diet	121	40.3	103	34.33	10	0.001***
	Health	25	8.33	51	17		
Familiar to live fish transport	Unseen	55	18.3	53	17.67	0.3	0.56
	Seen	91	30.3	101	33.67		
Shortage of live fish	Buy dead also	60	20	77	25.67	2.4	0.12
	Return w/o buy	86	28.7	77	25.67		
Purchasing fish conditions	Dead	60	20	77	25.67	2.4	0.12
	Live	86	28.7	77	25.67		
Live fish prefer reason	Freshness	92	30.7	105	35	0.9	0.35
	Price	54	18	49	16.33		
Dead fish discard Reason	Killing method	66	22	73	24.33	0.2	0.7
	Preservative	80	26.7	81	27		
Opinion on Live Fish Price	Optimum	120	40	122	40.67	0.4	0.52
	Expensive	26	8.67	32	10.67		

Significant at 0.05; ** Significant at 0.01;*** Significant at 0.001

3.3. Live fish business

Table 4. The correlation between different parameters of the live fish business

A. Retailer of live fish (n = 58)						
Parameters	A	B	C	D	E	F
A Purchase amount (Kg / lot)	1					
B Survival (%)	0.69***	1				
C Tank capacity(x1000L)	0.99***	0.7***	1			
D Total expense (NRs/day)	0.6***	0.43**	0.62***	1		
E Total income (NRs/day)	0.61***	0.44***	0.63***	0.96***	1	
F BC Ratio	0.47	0.23	0.46	0.28	0.46	1
B. Live fish suppliers(n=35)						
Parameters	A	B	C	D	E	F
A Purchase amount (Kg / lot)	1					
B Survival (%)	0.52***	1				
C Tank capacity(x1000L)	0.80***	0.35**	1			
D Total expense (NRs/day)	0.67***	0.37**	0.52***	1		
E Total income (NRs/day)	0.57***	0.28*	0.42***	0.89***	1	
F BC ratio	0.15	0.05	0.06	0.02	0.40***	1
G Farmers share ratio	0.08	-0.02	0.02	-0.06	0.32**	1 0.99***

Note: Strength of the correlation (r) = 0.0- 0.1 = no correlation; 0.1-0. 3 = low correlation; 0.3-0. 5 = medium correlation; 0.5- 0.7 = high correlation; 0.7- 1 = very high correlation; * significant at 0.05; ** significant at 0.01; *** significant at 0.001

Table 5. Comparison of different factors in the business of live fish of two major cities of Nepal

Description	Markets		Mann-Whitney U	
	Chitwan (18)	Kathmandu (40)	Statistics	p(0.05%)
A. Retailers				
Business Duration (Year)	3.78 ± 0.94	4.63 ± 1.48	234	0.03*
Purchase amount (Kg / lot)	98.51 ± 11.02	95.08 ± 14.81	295.5	0.28
Survival (%)	92.13 ± 1.25	89.42 ± 1.73	77.5	<.001***
Purchase rate (NRs / kg)	371.11 ± 15.06	373 ± 14.72	339	0.72
Sale rate (NRs/g)	462.22 ± 62.69	463.38 ± 41.69	329	0.6
Tank capacity(x1000L)	1.58 ± 0.35	1.68 ± 0.51	315	0.42
Rent (x100(NRs/day))	6.57 ± 0.39	8.16 ± 0.42	0	<.001***
Total expense (NRs/day)	20.75 ± 5.08	21.22 ± 7.18	347.5	0.83
Total income (NRs/day)	25.1 ± 7.70	25.27 ± 8.80	356	0.95
BC Ratio	1.21 ± 0.16	1.19 ± 0.12	319	0.49
B. Suppliers				
Business Duration (Year)	5.17 ± 1.25	5.82 ± 1.74	113.5	0.06
Purchase amount (Kg / lot)	133.33 ± 54.23	125.88 ± 30.83	136	0.55
Survival (%)	89.76 ± 4.15	88.88 ± 2.82	135.5	0.56
Purchase rate (NRs/ kg)	265.28 ± 18.82	260.29 ± 13.63	147	0.84
Sale rate (NRs/ kg)	371.39 ± 18.13	374.71 ± 9.02	151.5	0.96
Tank capacity(x 1000L)	1.33 ± 0.54	1.26 ± 0.31	138.5	0.61
Rent (X100(NRs/day))	56.67 ± 10.43.	111.76 ± 15.90	1	<.001**
Total expense (NRs/day)	41.06 ± 14.95	68.79 ± 16.14	36	<.001**
Total income (NRs/day)	49.21 ± 19.67	82.54 ± 20.22	37	<.001**
BC Ratio	1.21 ± 0.16	1.17 ± 0.13	116	0.22
Farmers share ratio	1.41 ± 0.1	1.44 ± 0.06	117.5	0.24

Table 6. Comparison of different factors in the business of live fish in two major cities, n=35

Problems	Market	Number	Mean rank	Cases (%)	p-Value
High Mortality	Chitwan	18	14.75	68.6	0.016*
	Kathmandu	17	21.44		
Administrative Obstacle	Chitwan	18	26.03	48.6	0.000***
	Kathmandu	17	9.5		
High Cost of Aeration	Chitwan	18	19.28	37.1	0.365
	Kathmandu	17	16.65		
Low- amount transport	Chitwan	18	18.36	25.7	0.777
	Kathmandu	17	17.62		
Total				180	

Significant at 0.05; ** Significant at 0.01; *** Significant at 0.001

A study of the Nepalese live fish market found that common carp accounted for 70.7% of sales. Rohu (46.3%) is more popular in Chitwan, and trout (42.3%) is more popular in Kathmandu. This shows that socioeconomic status and location do not affect people’s consumption habits of live fish. Common carp and Rohu, two of the largest commercial fish, are easy to find in the market. Therefore, Nepalese people choose live fish based on the availability of species. Both cities eat 62.2% live fish, as does the rest of the region. The demand for live fish depends on species availability; it is not affected by income or location. In addition to the benefits, peo-

ple of all ages and backgrounds agreed to eat live fish. This shows that the preferences of live fish are based on available species, not socioeconomic status or the location of the study site. Chitwanians give more priority on live fish more than dead fish for their nutritional value. Nutritional value, freshness, socioeconomic status, and location all have an impact on the demand for live fish in Chitwan Valley. Dead Rohu was healthy for the diet group, non-employee consumers, and employees. Live Rohu fish are considered local, so importing them is difficult.

Table 7. Factors affecting the survival of live fish in the live fish business

A. Suppliers(n=35)	Model I	Model II	Model III	Model-IV
Constant	82.36 (-35.2) ***	84.16 (47.35) ***	81.79 (56.4) ***	90.48 (81.08) ***
Purchase amount (Kg / lot)	-0.24(-0.07)			
Tank capacity(L)	0.95(0.28)	0.7(5.63) ***	0.65(4.87) ***	0.2(-0.66)
Blower with coarse-air stone	0.35(2.33) *	0.27(2.01) *	0.16(1.07)	-0.17(-1.26)
Coarse air stone vs. tank capacity				0.52(-1.7)
12-hour transport duration	-0.7(-3.06) **	-0.42(-2.65) **		
8 hours of transport duration	-0.33(-1.79)	-0.17(-1.21)		
To remove waste	-0.34(-2.46) *	-0.26(-2) *		
F-value	5.13***	7.51***	8.09***	9.81***
R 2	0.61	0.56	0.44	0.49
Adjusted R2	0.49	0.49	0.38	0.44
B. Retailer(n=58)				
Constant	85.58 (18.08) ***	85.58 (18.1) ***	87.62 (95.15) ***	89.93 (-69.13) ***
Purchase amount (Kg/lot)	0.55(2.6) ***	0.67(3.14) **		
Tank capacity(L)	-0.06(-0.32)	-0.21(-1.01)	0.37(2.97) **	0.09(-0.54)
Coarse air stone vs. tank capacity				-2.08(-2.16) *
Blower with coarse-air stone	-0.02(-0.2)			2.28(2.31) *
Total income (Nrs/day)	1.61(1.53)			
Total expenditure (Nrs/day)	-0.09(-0.1)	-0.07(-0.6)		
BC ratio	-0.3(-0.7)			
F-value	6.17***	7.29***	8.83**	5.25**
R 2	0.42	0.29	0.14	0.48
Adjusted R2	0.35	0.25	0.12	0.23

Significant at 0.05; ** Significant at 0.01;*** Significant at 0.001

From the regression analysis, the following four types of regression lines were estimated for the survival of fish.

Model 1

$$\text{Survivability} = 82.36 + -0.24\text{PA} + 0.95\text{TC} + 0.35\text{BWCAS} + (-0.7)\text{THTD} + (-0.34)\text{WR} \quad (\text{i})$$

Model 2

$$\text{Fish survival} = 84.16 + 0.7\text{TC} + 0.27\text{BWCAS} + (-0.42)\text{THTD} + (-0.17)\text{EHTD} + (-0.26)\text{WR} \dots\dots\dots(\text{ii})$$

Model 3

$$\text{Survivility} = 81.79 + 0.65\text{PA} + 0.16(\text{TC}) \dots\dots\dots(\text{iii})$$

Model 4

$$\text{Survivability} = 90.48 + 0.2\text{PA} + -0.17\text{BWCAS} + 0.52(\text{CAS} * \text{TC}) \dots\dots\dots(\text{iv})$$

Where,

PA =Purchase amount (kg/lot)

TC = tank capacity (L)

BWCAS= Blower with coarse-air stone

THTD = 12 -hours of transport duration

EHTD = 8 -hours transport duration

WR= Frequency of waste removal

Live fish have a shorter supply chain than dead fish due to transport issues. Live fish shipping supply chains were similar (Adhikari *et al.*, 2018). Nepal’s complicated aquaculture supply chain includes farmers, transporters, retailers, and customers. Rohu controls 25% of Nepal’s fish market. Chitwan has more Rohu options than Kathmandu. Trout outsells Rohu. Consumers prefer Rohu over the dead or living version in surveys in western Nepal (Gurung *et al.*, 2016) and Bangladesh (Rahman & Islam, 2020). Rohu and Terai’s observations are similar. Pangas were preferred to Magur (*Clarius sps*) (Gurung *et al.*, 2016). These studies found that Rohu is the best for Nepal’s Terai region and trout for its hilly area. The survey found that Rohu is preferred to other fish due to its affordability and taste. Its quality and taste are unquestionable. Preserved Rohu is used when fresh Rohu is not available. Therefore, the consumer responded that fish was preferred for health, as the same result of Rahman, unlike Kathmandu residents, who value the health benefits of eating live

fish, do Chitwan residents value its nutritional value? That is why Kresic *et al.* (2022) wanted to spread the word about fish’s health and nutritional benefits. Like Carlucci D. *et al.* (2015), the local consumer values fresh, locally caught, frozen fish. Responsible fishing improves fish nutrition (Lee & Sadovy, 1998), consumers prefer local products (Carlucci *et al.*, 2015), and Koreans place value on fish quality (Kim & Lee, 2018). Because domestic fish products are healthier (Lee & Sadovy, 1998). Due to concerns about synthetic contamination, silver carp and Naini fans prefer to buy them alive and fresh. Consumer income and family size affect price, freshness, and taste (Lee & Sadovy, 1998; Quagraine *et al.*, 2008; Uddin *et al.*, 2019) (Gurung *et al.*, 2016). Chitwan consumers prefer Rohu to Kathmandu consumers, which is just the opposite in the case of trout. Therefore, local farms in these markets sell fresh versions of both species. (Table 1). A separate study in the US found that fish eaters had lower education and income (Burger, 2002). “Grass carp” and “Pangas” are used by people who cannot read or write and do not work, while “common carp” is used by those who can read, write, and work. Therefore, reliable live fish transport technology is needed so that people can buy fish to meet their nutritional needs. Kathmandu businessmen understand live fish better than Chitwan. Tank size has a large impact on fish survival but a small impact on fish numbers. According to Berka (1986), the price depends on the tank size needed to safely transport the fish. Supplier income rises proportionally to the farmer’s share. But when there are many dead fish and the supplier’s margin is lower than usual, farmers must give some of their profit to the supplier. Nepalese consumers of live fish consider that the price of live fish is not expensive. If live fish move in a small amount of water using traditional methods, they will die. Adhikari *et al.* (2018) believe that transporting live fish is dangerous, expensive, and energy-intensive, and that carp must be kept alive longer.

Chitwan has far more bureaucratic problems than Kathmandu. Most of the respondents said that many fish died in Kathmandu (68.50%) and that there were many rules at the Chitwan site (48.50%) during transit. Zhang (2019) also mentioned the mortality of fish transport. Table 4 shows the mean rank comparison of multiple responses, showing that Kathmandu’s high mortality (68.50%) and Chitwan’s administrative problems (48.50%) are Nepal’s biggest live fish transport challenges. Moving live fish in small amounts of water is expensive due to high mortality (Zhang, 2019). Adhikari *et al.* (2018) suggest a change in the process

to ensure that carp arrive safely. The biggest problem is fish mortality (Table 4). It is a claim that passive aeration methods, such as microporous tubes (2%), porous stones (5%), and ceramic diffusers (44%), have much lower gas solubility than active methods, such as the venturi nozzle (60%) and the oxygenation cone (80%). The lack of aeration equipment poses two main risks to fish survival. First, the causes of fish mortality are being investigated. Thus, ordinary least squares (OLS) regression was used to determine the many factors that affect fish survival during marketing and transportation and how many fish survive. According to Timsina *et al.* (2018), multiple linear regression was used to examine interrelationships and estimate their predictive value. Model III of transport and marketing uses the SD of factors that affect the survival of live fish. The four regression models for shipping live fish are highly significant. The blower's coarse air stones share Model III's SD of 0.16. 44% of live fish transport success rates are due to constants. Most fish tanks use coarse air stones for aeration, which only release 3 to 5 mg/L of oxygen into the water and stress most fish. Small bubble sizes (Oliveira *et al.*, 2018) and DO increases to 25 from 6.5 mg/L (Mahasri, 2018) can increase fish survival by 44% compared to current practice. To improve the survival of live fish in transport, switch from coarse air stones to small bubbles.

5. CONCLUSION

Live Rohu (70.7%) and common carp (46.3%) are sold at the Nepalese fish market that each person eats. With the growing popularity of fish consumption in Nepal, the demand for live Rohu and common carp increases,

which is increasing prices and makes these two species more popular. Geographic and population factors that have not changed in the consumption pattern beside the concern for the benefit of the fish consumer groups. The high mortality rates and administrative obstacles present problems with the live fish supply chain, which is the biggest concern for both people who work in the business and customers. The survey found that the high death rate is due to the small size of the transport tank with aeration of the rough air stone. Because of these things, a lot of air or oxygen diffuses out through the water rather than dissolving in it. This research aims to find a link between cause and effect that explains how the aeration instruments and the transport tank affect each other. The results of this study show that the aeration system needs to be reexamined so that the maximum amount of gas dissolution that can occur in the transport tank can be increased to meet the demand for live fish in the supply and retailer market.

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Annex: 1

1. Survey form of live fish consumer’s perception

Parameters	Options		
1. Your residential location	Bagmati Terai	Bagmati hills	
2. education level	literate	school	university
3. profession	employed	unemployed	
4. Do You Eat Fish?	Yes	No	
5. Benefits of fish consumption	Diet	Health	
6. Can You Identify Fish species?	Yes	No	
7. Favorite Fish species (Choose At Least Two)	Common carp	Pangas	Like Rohu Tilapia Trout
8. What Will You Do If You don’t Find Live Fish In Market?	Return without buy		Buy dead also
9. Which Factor Do You Prioritize When While Buying Fish?	Freshness	Price	
10. What Type of Favorite Fish Do You Prefer?	Live	Dead	
11. Favorite Source of Fish	Hills	Terai	
12. Difference In Price of Dead and Live Fish	Optimum	Expensive	
13. Why Don't You Prefer to buy dead fish?	Unknown killing method		Unknown preservative
14. Have You Ever Seen Transporting Live Fishes?	Yes	No	

2. Survey form on the status of live fish suppliers

Parameters	Option/amount		
1. Your Business address?			
2. Business duration (year)?			
3. Farm gate price?			
4. Purchase amount (kg/lot)?			
5. Purchase rate of live fish Nrs/kg)?			
6. Retailer price (Nrs/kg)?			
7. Transported tank capacity (L)?			
8. Transport duration (hr)?			
9. Rent of vehicle (NRS/Day)?			
10. Aeration Instruments?	Oxygen cylinder coarse air stone	Blower with coarse air stone	
11. Reason for of washing?	To maintain Temperature	To remove waste	
12. Problems in Live Fish Transportation?	High Cost of Aeration	High Mortality	Low amount Transport Administrative obstacle

3. Survey form on the status of live fish retailer’s retailer

Parameters	Option/amount		
1. Your business address?			
2. Business duration (year)?			
3. Purchase price from suppliers (Nrs/kg)?			
4. Purchase amount (kg/ lots)?			
5. Dead within purchase (kg)?			
6. Consumer price (Nrs/kg)?			
7. Sales Sale duration (days)?			
8. Daily sales sale amount (kg)?			
9. Installation tank capacity (L)?			
10. Rent of shop (NRS/Day)?			
11. Aeration Instruments?	Oxygen cylinder coarse air stone	Blower with coarse air stone	
12. Energy sources source for aeration?	Domestic electricity	Installed Backup power	