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Blue economy in the green fields: rethinking value chain analysis of inland fisheries in Bangladesh

Abstract

Bangladesh ranks as the third largest country in terms of inland freshwater resources. This study seeks to explore the current development of the inland cultured fish market value chain and the criteria for its expansion. A field survey was conducted across inland fishery farms in eight districts, representing all eight divisions of Bangladesh. From each district, four farms were selected, including small, medium, and large operations. Regression analyses were performed on various covariates in relation to total sells, with and without resampling. Key factors identified as significant include total production, farmer's age, farm size, electricity costs, minnow expenses, culture duration, loan transactions, and specific regional divisions. The findings suggest that as farmer's age, expand their farm areas, and extend the culture period, total sells are likely to increase. According to the survey data, retailers enjoy the highest profit margin at 29%, while farm owners or farmers hold the second highest margin at 26% for inland carp fish.

Keywords: inland fishery, Bangladesh, value chain analysis, carp fish, regression

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Introduction

Bangladesh, with its extensive network of rivers and water bodies, has a rich tradition of inland fisheries that play a crucial role in the country's economy, food security, and employment. The value chain analysis of Bangladesh's inland fishery sector offers insights into the various stages of production, processing, distribution, and marketing, highlighting value addition at each step and identifying opportunities for improvement and growth.

Multiple studies have explored the inland fishery value chain in Bangladesh. Islam and Habib[1] and Hossain and Masud[2] emphasize the need for more equitable value distribution within the supply chain. Deb et al.,[3] and Ahmed[4] focus on fish price volatility and the marketing of low-value cultured fish, respectively. These studies collectively underline the importance of equitable value distribution and improved marketing strategies in the inland fishery industry.

In particular, the inland fishery sectors of tilapia fish seed and low-value cultured fish have been the focus of several studies. Rahman et al.[5] conducted a value chain analysis focusing on the Mymensingh district, while Ahmed[4] provided a broader analysis. Deb et al.[3] examined fish price volatility and its relationship with aquaculture growth. Pijl[6] offered a broader overview of Bangladesh's seafood sector, stressing the need for a comprehensive understanding of the industry. These studies highlight the importance of the inland fishery sector in Bangladesh and the potential for further research and development.

Other studies have delved into the sustainability and value chain of Bangladesh's inland fisheries. Prodhan et al.[7] highlight the importance of information sharing and commitment to improve supply chain performance, while Deb et al.[3] link reduced fish price volatility to aquaculture's rapid growth. Acharjee et al.[8] examine the price transmission among different market levels, finding a mix of symmetric and asymmetric behaviors. Barman et al.[9] assess the stock status of croaker fisheries in the Bay of Bengal, advocating for specific management measures to ensure sustainability. These studies collectively emphasize the complex dynamics of the inland fishery value chain in Bangladesh and the need for further research and policy interventions.

Inland fisheries are vital for food security and livelihoods in Bangladesh, which ranks third globally in inland fisheries production.[10] Value chain interventions, such as reducing postharvest losses, could significantly enhance the food security contributions of inland fisheries.[11] The inland fishery value chain in Bangladesh spans various stages, from product movement to market reach, with fishery-related threats impacting each link.[12] Inland fisheries support over 60 million people in low-income countries, with women making up over half of the workforce in these supply chains.[13] Globally, over 90% of inland fishery production is consumed by humans, underscoring its importance in providing essential nutrients like Vitamin A and zinc, particularly in Bangladesh.[14] Despite challenges such as the COVID-19 pandemic, Bangladesh has excelled in inland open water capture fisheries, ranking third globally, and in culture fisheries, ranking fifth.[15] Sustainable management is essential to ensure long-term resource availability and address ethical considerations related to resource responsibility and fairness.[16]

In conclusion, Bangladesh's inland fishery value chain is fundamental to food security and livelihoods, contributing significantly to the economy and nutritional security. Sustainable management practices, value chain interventions, and addressing threats to the chain are crucial for maximizing the benefits of Bangladesh's inland fisheries sector.

While the blue economy is generally associated with the ocean economy,[17,18] this study analyzes the inland pond culture fishery within the blue economy framework and its impact on Bangladesh's GDP. According to a FAO report,[19] Bangladesh ranks third in inland open water capture production and fifth in global aquaculture production. The fisheries sector contributes 3.5% to Bangladesh's GDP, with a stable growth rate of 5.01% over the last decade.[20] About 12% of the labor force is directly or indirectly involved in fisheries

for their livelihood. Among the three major segments of the fishery sector (inland capture, inland culture, and marine), inland culture has shown a significant growth rate of 3.91% in 2018-19. Given this consistent growth, despite challenges like climate change, floods, and pandemics,[21] it is crucial to understand how the inland culture fishery sector contributes to the economy at both micro and macro levels.

This study adopts a multidisciplinary approach to achieve its objectives. It primarily focuses on statistical and econometric modeling to illustrate the value chain system. An anthropological perspective is also considered to study the livelihood patterns of fish farmers. The study examines the relationship and influence of cultured farm fishery production on both micro and macro-economic perspectives. The chain model reflects the interdependent economic activities linked vertically between phases such as production, distribution, wholesaling, retailing, and consumption.[22] The structural value-chain model has been applied in previous studies to explain the contribution of fish and agricultural production to GDP growth.[23–26] This study aims to measure the segmented contribution of the culture fish market supply chain. Agriculture and fishery productivity promote a shift in labor to higher productivity sectors, resulting in higher real income and GDP growth.[27] The gravity model explains how technological and financial incentives for fish farmers boost productivity despite a shift from farm to off-farm sectors.[28] Economic growth is assumed to follow structural changes, and value-chain analysis with micro and macro-level panel data is an appropriate tool to measure these changes.[25,26,29–31] Therefore, this study is designed to gather information through micro-level surveys, macro-level secondary data, and qualitative approaches to observe coping strategies and livelihood patterns of fish farmers.

The fishery sector promotes employment creation, achieving SDG targets, enhancing exports and GDP growth, mitigating poverty,[32] ensuring food and nutrient security,[33] and maintaining a balanced ecosystem.

This comprehensive analysis aims to provide a detailed understanding of the value chain dynamics in Bangladesh's inland fishery sector, highlighting key challenges, opportunities, and interventions for sustainable development and growth. Through empirical research, stakeholder consultations, and policy analysis, this study seeks to contribute to the body of knowledge on inland fisheries and inform decision-making processes for the benefit of all stakeholders involved.

Methodology

To measure structural changes and value chain analysis of the fishery sector, a micro-level survey on farm owners, stakeholders, whole sell supply-market, mid-supply chain, and whole sell demand-market is conducted. The growth of the inland fisheries sector can contribute to the national economy in several ways: Direct contribution: The inland fisheries sector generates income and employment opportunities for fish farmers, processors, distributors, and other actors in the value chain. This leads to increased consumer spending, tax revenues, and overall economic growth. Indirect contribution: The growth of the inland fisheries sector can stimulate demand for inputs such as fish feed, boats, and fishing gear, leading to increased economic activity in related sectors. Export earnings: Inland fisheries products can be exported to other countries, generating foreign exchange earnings and boosting national income.

Research methods

This study implemented quantitative and qualitative methods for data collection. Quantitative survey data are analyzed through statistical tools. Bivariate and multivariate modelling, including simulation, are used to detect the elasticities of covariates on the fish selling amount.

Detailed sampling plan

This study conducted a field survey across inland fishery farms in eight districts, representing all eight divisions of Bangladesh. From each district, four farms were selected, including small, medium, and large operations, resulting in an initial sample of 32 inland fishery farms. However, data from one farm had to be excluded due to significant missing values, leaving 31 farms in the final dataset. The primary data collection took place between January 5 and 19, 2024, using a structured questionnaire administered through in-person interviews. Prior to the survey, 12 surveyors underwent a 3-day training program, followed by a 2-day pilot survey to finalize the questionnaire.

The field survey was conducted on farms in Manikganj (Dhaka division), Rajshahi (Rajshahi division), Cumilla (Chattogram division), Jashore (Khulna division), Barishal (Barishal division), Habiganj (Sylhet division), Mymensingh (Mymensingh division), and Dinajpur (Rangpur division). In addition to the farms, the study also surveyed traders (Bepari), wholesellrs (Paiker, Arotdar), retailers (supermarkets and local markets), and consumers. Eight Key Informant Interviews (KIIs) were conducted in each division. The in-person interviews covered various types of inland fish species, including carp, pangas, and tilapia, of different sizes.

Analysis and results

The analysis in this study begins with bivariate statistics, presenting the averages of continuous covariates followed by frequency tables for categorical variables. As shown in Table 1, the inland fishery farms have a mean annual sells revenue of BDT 1.2 million. The average annual production across the 31 fishery farms is 5,800 kilograms. The farmers have an average age of 46 years, with the mean education level being secondary schooling. The average farm size is 1,400 decimals, while the mean annual electricity bill amounts to approximately BDT 120,000. The average yearly cost of preparing the farm per decimal is around BDT 384. On average, farms spend BDT 1,400 annually on purchasing minnows, and the fish culture process typically lasts 9 months. The mean annual cost of farming equipment is BDT 288.

Table 1 Summary statistics of continuous covariates

	Mean
Total yearly sell	1197738.4
Total yearly production	5819.839
Age	45.71
Schooling	9.645
Farm size (decimal)	1429.387
Electricity bill	117341.93
Cost of farm	383.774
Cost of minnow	1398.323
Months cultured	9.194
Cost of equipment	288.226

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Table 2 shows that 65% of farm owners use machine-oriented processes, while 35% rely on traditional methods. Table 3 indicates that only 16% of the randomly selected farmers prefer using loans, with the majority (84%) opting for cash transactions. Table 4 reveals that 68% of the sampled farmers possess a trade license. Finally, Table 5 presents the distribution of sampled farms across all eight divisions of Bangladesh.

Table 2 Type of culturing the farm

Culture type	Freq.	Percent	Cum.
Traditional	11	35.48	35.48
Machine	20	64.52	100
Total	31	100	

Table 3 Type of money transaction

Money transaction	Freq.	Percent	Cum.
Cash	26	83.87	83.87
Loan	5	16.13	100
Total	31	100	

Table 4 Having trade license

Trade license	Freq.	Percent	Cum.
Yes	21	67.74	67.74
No	10	32.26	100
Total	31	100	

Table 5 Sampling from different divisions

Division	Freq.	Percent	Cum.
Dhaka	4	12.9	12.9
Chattogram	4	12.9	25.81
Rajshahi	4	12.9	38.71
Khulna	4	12.9	51.61
Barishal	4	12.9	64.52
Sylhet	4	12.9	77.42
Mymensingh	3	9.68	87.1
Rangpur	4	12.9	100
Total	31	100	

This study employs multivariate regression analysis to examine the statistical relationship between total sells of inland fishery farms and various covariates. Given the small sample size of 31 farms, the Jackknife resampling method is applied to obtain consistent estimates.[34] As outlined in Table 6, only a few covariates are statistically significant. For instance, increasing production by 1 kilogram is associated with an average increase in total sells of BDT 171. Additionally, extending the fish culturing period by 1 month results in an average increase in total sells of BDT 21,000. Notably, farms in the Khulna division demonstrate higher sells compared to those in Dhaka, the capital.[35]

Table 6 Linear regression of covariates on total yearly sells with Jackknife resampling

	Coef.	St.Err.	t-value	p-value	[95% conf interval]		Sig
Total production	171.295	40.362	4.24	0	88.864	253.725	***
Age	10328.408	7263.221	1.42	0.165	-4505.07	25161.885	
Schooling	-7404.944	13909.405	-0.53	0.598	-35811.739	21001.851	
Farm size (decimal)	33.581	39.264	0.86	0.399	-46.607	113.769	
culture type: base (traditional)	0	.	.	.	.	.	
Machine	14561.425	75513.105	0.19	0.848	-139656.91	168779.76	
Electricity bill	0.555	0.341	1.63	0.114	-0.141	1.252	
Cost of farm	-610.514	822.745	-0.74	0.464	-2290.784	1069.755	
Cost of minnow	48.388	44.994	1.08	0.291	-43.501	140.277	
Months cultured	21579.825	12424.856	1.74	0.093	-3795.116	46954.767	*
Cost of equipment	-75.266	367.422	-0.2	0.839	-825.643	675.111	
Money transaction: base (cash)	0	.	.	.	.	.	
loan	177284.17	150085.57	1.18	0.247	-129231.46	483799.8	
Trade license: base (yes)	0	.	.	.	.	.	
no	-20129.192	63683.495	-0.32	0.754	-150188.24	109929.85	
division: base (dhaka)	0	.	.	.	.	.	
Chattogram	148328.8	122586.18	1.21	0.236	-102025.57	398683.17	
Rajshahi	-377435.8	441629.69	-0.85	0.4	-1279363.9	524492.34	
Khulna	744671.29	199684.44	3.73	0.001	336861.26	1152481.3	***
Barishal	-58950.405	92205.922	-0.64	0.527	-247260.02	129359.21	
Sylhet	25515.686	162589.43	0.16	0.876	-306536.22	357567.6	
Mymensingh	-261560.87	613184.95	-0.43	0.673	-1513851.6	990729.87	
Rangpur	67135.022	144037.14	0.47	0.645	-227028.07	361298.11	
Constant	-400148.49	895221.21	-0.45	0.658	-2228434.1	1428137.1	
Mean dependent var	1197738.387	SD dependent var	726781.85				
R-squared	0.997	Number of obs	31				
F-test	96.468	Prob > F	0				
Akaike crit. (AIC)	785.799	Bayesian crit. (BIC)	814.479				

*** p<.01, ** p<.05, * p<.1

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Table 7 presents the regression analysis of covariates on total sales without applying the resampling process. Despite the small sample size of 31 farms, linear regression without resampling identifies more significant covariates.[36–39] The Akaike and Bayesian information criteria are consistent with those from the resampling regression model. Significant factors include total production, farmer's age, farm size, electricity bill, cost of minnows, duration of fish culturing, loan transactions, and specific divisions.

Table 7 Linear regression of covariates on total yearly sells without resampling

	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]		Sig
Total production	171.295	13.926	12.3	0	140.644	201.946	***
Age	10328.408	3085.454	3.35	0.007	3537.368	17119.447	***
Schooling	-7404.944	8427.851	-0.88	0.398	-25954.518	11144.63	
Farm size (decimal)	33.581	13.319	2.52	0.028	4.266	62.897	**
culture type : base (traditional)	0	.	.	.	.	.	
Machine	14561.425	65007.576	0.22	0.827	-128519.28	157642.14	
Electricity bill	0.555	0.154	3.61	0.004	0.217	0.894	***
Cost of farm	-610.514	512.103	-1.19	0.258	-1737.646	516.617	
Cost of minnow	48.388	25.105	1.93	0.08	-6.868	103.644	*
Months cultured	21579.825	7431.556	2.9	0.014	5223.081	37936.57	**
Cost of equipment	-75.266	174.515	-0.43	0.675	-459.371	308.839	
Money Transaction: base (cash)	0	.	.	.	.	.	
Loan	177284.17	55168.911	3.21	0.008	55858.215	298710.13	***
Trade license : base (yes)	0	.	.	.	.	.	
no	-20129.192	38486.751	-0.52	0.611	-104837.96	64579.576	
division: base (dhaka)	0	.	.	.	.	.	
Chattogram	148328.8	78609.728	1.89	0.086	-24690.045	321347.65	*
Rajshahi	-377435.8	174464.41	-2.16	0.053	-761429.39	6557.782	*
Khulna	744671.29	118299.59	6.29	0	484295.64	1005046.9	***
Barishal	-58950.405	59502.551	-0.99	0.343	-189914.64	72013.827	
Sylhet	25515.686	94781.414	0.27	0.793	-183096.8	234128.17	
Mymensingh	-261560.87	201807.53	-1.3	0.221	-705736.25	182614.51	
Rangpur	67135.022	81601.197	0.82	0.428	-112468	246738.05	
Constant	-400148.49	431824.44	-0.93	0.374	-1350587.7	550290.69	
Mean dependent var	1197738.387		SD dependent var	726781.85			
R-squared	0.997		Number of obs	31			
F-test	179.476		Prob > F	0			
Akaike crit. (AIC)	785.799		Bayesian crit. (BIC)	814.479			

*** p<.01, ** p<.05, * p<.1

The analysis shows that for each additional year in a farmer's age, total sales increase by an average of BDT 10,000. An increase of 1 decimal in farm area corresponds to an average sales increase of BDT 33.[40] Higher expenditures on minnows, indicating a larger quantity of minnows, are associated with increased sales. Extending the fish culturing period by 1 month results in an average sales increase of BDT 22,000. Although the sample includes few fish farmers, the data suggests that those who have access to loans for transactions can achieve higher sales. Additionally, farms in the Khulna and Chattogram divisions report higher sales compared to those in Dhaka, which is reasonable given the larger inland fishery areas and better facilities in these regions.[41–42]

Figure 1 illustrates that retailers hold the highest profit margin at 29%, followed by farm owners or farmers, who have a 26% profit margin for inland carp fish based on the surveyed data. Profit margins vary depending on the type of fish, and this study considered an average value chain analysis across different species.

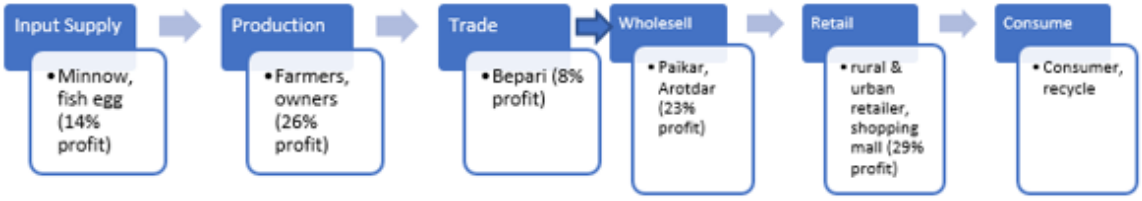

Figure 1 Fish value chain of inland carp (Rohu, Catla, Kalbasu, Mrigal).

Note From own survey from eight divisions of Bangladesh, medium size 1.5-2.5 kilogram carp fish, mean value from market analysis.

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Conclusion

The value chain analysis of inland fisheries in Bangladesh underscores the various stages involved in the production, trade, and distribution of fish. While the sector faces numerous challenges, such as input supply, production, processing, and marketing, there are significant opportunities for improvement through value addition, innovation, and strategic interventions. By addressing these challenges and leveraging these opportunities, Bangladesh can unlock the full potential of its inland fishery sector, driving economic growth, enhancing food security, and fostering rural development.[43]

In the context of inland fisheries, the value chain encompasses all the activities required to bring a fish product from its initial stages, such as fishing or aquaculture, to the end consumer. Bangladesh's value chain for inland fisheries is particularly complex due to the countries diverse and abundant water resources, which play a major role in its fish production.[15]

Various studies have identified challenges and inefficiencies within this value chain. For instance, the fish supply chain is often dominated by a few large players, with numerous intermediaries who add cost without contributing value. This situation is further complicated by a "patron-client relationship" that influences market dynamics.[11] Additionally, significant post-harvest quality losses, especially for small indigenous species, reduce overall market efficiency.[12] The export market also faces challenges related to infrastructure and hygiene standards, which affect international buyer relations.

To address these challenges, policy interventions could include: Infrastructure investments: Improving roads, electricity, and water supply can reduce production costs and enhance the quality and quantity of fish products. Capacity building: Providing training and education to fish farmers and processors can boost their productivity, efficiency, and market competitiveness. Market access: Facilitating access to both domestic and international markets can increase demand for inland fisheries products and boost export earnings. Technology adoption: Promoting new technologies in fish farming, processing, and packaging can improve the quality and safety of fish products, thereby enhancing their marketability.

By modernizing the fish market, improving infrastructure, and adhering to international standards, Bangladesh can significantly enhance the efficiency and quality of its inland fisheries, strengthening the economic health of its fishing industry.[10,12]

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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