Exploring the Influence of Economic and Environmental Knowledge on Fish Production in Rural-Bangladesh

Дослідження впливу економічних та екологічних знань на виробництво риби в сільській місцевості Бангладеш

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Received: June 08, 2025 | Revised: June 25, 2025 | Accepted: June 30, 2025

DOI: 10.33445/sds.2025.15.3.25

Purpose: is to investigate the impact of economic and environmental knowledge on fish production in rural Bangladesh. The research seeks to determine how various factors, such as human labor costs, feed costs, manure, fingerlings, water supply, and environmental knowledge, influence fish production per hectare.

Method: Primary survey, sample selection, Cobb-Douglas production function, resource allocation efficiency analysis.

Findings: Cost Structure: Human labor accounts for the largest portion of the variable costs for all farmer categories (marginal, small, and medium). Medium farmers have lower human labor costs compared to marginal farmers, and feed is a significant expense for small and medium farmers. Marginal farmers face high fingerling costs. Land use and interest are fixed costs. **Regression Analysis:** Human labor cost, feed cost, manure cost, and water supply cost have a statistically significant positive relationship with fish production per hectare. Feed cost has the most significant positive impact. Environmental knowledge also has a positive impact on fish production. **Environmental Knowledge:** Farmers often lack knowledge about environmentally friendly fish feed, but increased environmental awareness is associated with better fish production.

Theoretical implications: The research contributes to understanding the factors influencing fish production in rural Bangladesh, with a specific focus on economic and environmental variables. It uses a Cobb-Douglas production function to model the relationship between inputs and output in fish farming, providing a quantitative framework for analysis. The paper identifies the significance of environmental knowledge, highlighting its role in achieving sustainable aquaculture practices.

Practical implications: Targeted Investments: The findings can guide policies aimed at supporting fish farmers. The importance of human labor, feed, water supply and manure can encourage governments to invest in these sectors. **Promotion of**

Мета дослідження: полягає у дослідженні впливу економічних та екологічних знань на виробництво риби в сільських районах Бангладеш. Дослідження прагне визначити, як різні фактори, такі як витрати на людську працю, корм, гній, мальки, водопостачання та екологічні знання, впливають на виробництво риби на гектар.

Метод дослідження: Первинне опитування, виробнича функція Кобба-Дугласа, аналіз ефективності використання ресурсів.

Результати дослідження: Структура витрат: Людська праця становить найбільшу частину змінних витрат для всіх категорій фермерів (маргінальних, малих та середніх). Середні фермери мають нижчі витрати на людську працю порівняно з маргінальними фермерами, а корм є значною статтею витрат для малих і середніх фермерів. Маргінальні фермери стикаються з високими витратами на мальків. Використання землі та відсотки є фіксованими витратами. **Регресійний аналіз:** Витрати на людську працю, вартість корму, вартість гною та витрати на водопостачання мають статистично значущий позитивний зв'язок з виробництвом риби з гектара. Вартість корму має найбільший позитивний вплив. Екологічні знання також позитивно впливають на виробництво риби. **Екологічні знання:** Фермерам часто не вистачає знань про екологічно чисті рибні корми, але підвищення екологічної обізнаності пов'язане з покращенням виробництва риби.

Теоретична цінність дослідження: Дослідження сприяє розумінню факторів, що впливають на виробництво риби в сільських районах Бангладеш, з особливим акцентом на економічні та екологічні змінні. Воно використовує виробничу функцію Кобба-Дугласа для моделювання взаємозв'язку між вхідними даними та випуском у рибництві, надаючи кількісну основу для аналізу. У статті визначено важливість екологічних знань, підкреслюючи їхню роль у досягненні стійких методів аквакультури.

Практична цінність дослідження: **Цільові інвестиції:** Результати можуть служити орієнтиром для політики, спрямованої на підтримку рибних фермерів. Важливість людської праці, корму, водопостачання та гною може спонукати уряди

Environmental Awareness: The research supports promoting environmentally friendly practices. The study encourages education programs to provide farmers with environmental knowledge of sustainable fishing practices, or by providing financial incentives. **Marketing Efficiency:** The suggestion of reducing marketing intermediaries and establishing efficient wholesale and retail networks can help maximize profit for fish farmers.

Paper type: theoretical.

інвестувати в ці сектори. **Підвищення екологічної обізнаності:** Дослідження підтримує просування екологічно чистих методів. Дослідження заохочує освітні програми для надання фермерам екологічних знань про стійкі методи рибальства або шляхом надання фінансових стимулів. **Ефективність маркетингу:** Пропозиція щодо зменшення кількості маркетингових посередників та створення ефективних оптових та роздрібних мереж може допомогти максимізувати прибуток для рибних фермерів.

Тип статті: теоретичний.

Key words: Marginal-farmers, environmental knowledge, green economy, sustainable marketing, Rural-Bangladesh.

Ключові слова: Маргінальні фермери, екологічні знання, зелена економіка, сталий маркетинг, сільська місцевість Бангладеш.

Introduction

Bangladesh is a riverine country. It is endowed with vast water resources in the form of ponds, lakes, streams, and rivers covering an area of 4.65 million ha from where fish can be produced profitably (DoF, 2008). Rice and fish are the main food of almost all of the Bangladeshi and fish is the main source of animal protein for the common people in the country. In 2005 total production of fish was 2.22 million tons of which 40% was produced from closed water fisheries. There are around 0.24 million ha pond in Bangladesh which is around 63% of the total closed water fisheries. Pond culture of fish and shrimp for commercial purposes started in an organized manner only from 1980. This fisheries sector contributes near about 3.74% to GDP, 4.04% in export earnings and 20.87% to agriculture and 58% of animal protein to the daily diets of the population in 2007-08 (DOF, and Ministry of Fisheries & Livestock). This sector provides full-time employment of 1.4 million professional fishers and fish farmer, and 11 million part-time fishers, fish farmer and women, which is about 10% of total population (Alam et al., 2010). If five persons are involved in the fish production activities per ha, it may be possible to create the employment opportunity for about 40,000 people per year (Kumar et al., 2008). Not only in fish production but also in marketing sector people can create employment job facilities. Usually fish passes through several intermediaries from the fisherman or fish pond to the consumer. The intermediaries are involved in providing services of head loading, processing, preservation, packing and transporting and these activities result in cost addition at every stage of marketing (Bishnoi, 2005). The key intermediaries in fish marketing are: auctioneer, wholesaler, retailer and the vendor. Several other intermediaries like local fish collectors and fishermen cooperatives also exist in several markets.

But fish marketing is confronted with certain problems that are greater uncertainty in fish production, highly perishable nature of fish, assembling of fish from numerous landing centers, too many species and as many demand pattern, violent and frequent fluctuations in prices, difficulties in adjusting supply to variations in demand and need for transportations of fish in specialized means of transport (Rao, 1983).

Research Objective

1) To find out effect of the economic and environmental knowledge on fish production in Rural-Bangladesh

Research Questions

2) How does economic efficiency effect on fish production in Bangladesh?

How does environmental knowledge effect on fish production in Bangladesh?

Theoretical background

At present it contributes 4% of total Gross Domestic Product (GDP), 9% of foreign exchange earnings and 75% of the daily per capita animal protein intake (Ali, 2008). In fact, in a country like Bangladesh where pond fish culture can be expected to play an important role in supplying ever-increasing fish needs of the people (Chowdhury and Taharjan, 2001). It is estimated that in Bangladesh around

400,000 ha of freshwater ponds and more than 900,000 households are involved in aquaculture (DoF, 2005).

Shrimp is one of the leading exportable products in Bangladesh. Bangladesh is earning about 500 million of foreign currency yearly by exporting shrimp and contributing 3.78% in GDP (Das, 2013). Shrimp production is the second largest export sector of Bangladesh after readymade garments with a share of about 5 percent in Bangladesh's total exports in the 1990s. In FY2003 shrimp exports amounted to US$ 297.04 million, which was 4.54 percent of total exports. The share of shrimp export in total export income from fish and fish products is almost 90 percent (FAO, 2003). More than 2 million people are engaged in upstream and downstream activities related to shrimp industry in the country – in harvesting, culture, processing, exporting and other ancillary activities (Hussain, 2003).

Naturally fish and fishery products are highly traded commodities (Ahmed and Rahman, 2005). So, to make fish available to consumers at the right time and in the right place an effective marketing system is required. Marketing plays a very vital role in economic development as it stimulates production, avoids unnecessary fluctuations in output and prices and reduces costs of production. It can convert the latest demand into effective demand (FAO, 2005). In Bangladesh, fish marketing is exclusively maintained by the privet sector. Four distinct tires viz. primary, secondary, higher secondary and consumer market of marketing systems are observed in the process of distribution of fishes in Bangladesh (Alam, 2000). Normally fish passes through several intermediaries from the fishpond or fisherman to the consumer. The intermediaries are involved in providing services of head loading, processing, preservation, packing and transporting and these activities result in cost addition at every stage of marketing (Bishnoi, 2005). The key intermediaries in fish marketing are auctioneer, wholesaler, retailer and the vendor. Several other intermediaries like local fish collectors and fishermen cooperatives also exist in several markets. The biggest challenge in documenting intermediaries in fish marketing is their multifunctional performances. There is no strict boundary between intermediaries, and they perform several functions while marketing fish (Kumar et al., 2008).

In Asia, fish farming has been a natural addition to rice farming for thousands of years. Vegetable scraps and crop residues are fed to the fish, and the fish produce waste that is used to fertilize the rice fields.

The Department of fisheries of Bangladesh had classified all ponds into three categories; (i) derelict pond (9.42%) (ii) culturable pond (17.54%) and (iii) cultured ponds (63%). The total fish production from ponds is around 250thousand metric tons (Majid, 1995). Flowra (2012) in 1975-76 the country's fish production from all sources was 640,000 tons. In 1993-94, this production rose to 1,087,000 tons, whereas the per capita fish consumption went down from 33.4 g to 21g. This has happened simply because fish production increased at an arithmetical rate whereas the human population increased in geometrical proportion. The government-approved hatcheries produce around 120 corer giant freshwater prawns a year against the demand for 120 to 150 corers. The smuggled fry do not grow big, 30-40 of the Indian variety shrimps make one kilogram, but four of the local adult lobsters weigh the same. The Indian fry grown in hatcheries in Andhra Pradesh and Orissa, are sent to Bangladesh after 10/12 days. Lawal (2004) represents the market for frozen shrimp in the USA has not melted down as some feared might happen in the United States, as well as markets a retail range of frozen shrimp products. International pressure on wild, caught species, increasing global incomes, importing significant quantities of seafood products, and a strengthening demand in these countries, have all combined to result in a steady rise in international prices for shrimp, and the growing importance for cultured shrimp

Rao (1983) had emphasized that an efficient fish marketing system could eliminate some of the depressed pockets of malnutrition by supplying fish at reasonable prices to people living on subsistence level. Marketing efficiency was calculated as the ratio of consumer’s price to total

marketing cost and margins (Shepherd, 1972). The higher the ratio, the higher is the marketing efficiency and vice-versa (Elenchezhian and Kombairaju, 2004). Hye (1998) said that among Kaptai lake fisher 400 to500 fishing units were engaged each year of which 75% are floating gill nets and others seine net, dip net longlines etc.

Moreover, Bangladesh exports its fishery product to more than 55 countries, where the European Union is the major hub (Shamsuzzaman et al., 2017). However, Bangladesh is considered as still a trade-deficit country in terms of its fishery-resources which is contradictory to the motion of the country. In Bangladesh, there is an apparent difference between the inland and marine fisheries production trend from FY'1984-85 to FY'2018-19 (Sunny et al., 2021). The trend of freshwater fisheries yields from 2007 to 2019 presents a production gap between freshwater capture and freshwater culture (Hasan et al., 2021).

The influence of the fisheries sector was 2.54% of the GDP of Bangladesh in 2021 (Manik, 2023). Either directly or indirectly, nearly 12% of the country's population depends on fisheries and aquaculture-related activities for their livelihoods pattern (Department of Fisheries, 2020). The long-term Climate Risk Index expressions a 28.3 score that ranks Bangladesh the seventh among the tenth most affected countries in the world due to climate change effect (Eckstein et al., 2021). About 90% of global aquaculture is supplied by developing countries which are measured global climate risk as hotspots (Islam et al., 2019). Overpopulation effect and climate change are main difficulties in Bangladesh.

Data and methods

Research Methodology

This study is mainly based on a primary survey which is based on simple random sampling. The author selects 5 villages randomly. The author collects data from agricultural village offices to conduct this survey. The author selects five villages named *Chachibunia, Chokrakhali*, *Kochubunia, hatbati, Hogolbunia, taking 40 fish farms from every village for fish 200 farms.*

1 Cobb-Douglas production function

This function was used to estimate the effects of various inputs for the production of Koi fish. The functional form of the Cob-Douglas multiple regression equation was as follows.

$$Y = aX1\ b1\ X2\ b2\ X3\ b3\ X4\ b4\ X5\ b5\ X6\ b6\ X7\ b7\ X8\ b8\ X9\ b9eu$$

The equation may be alternatively expressed in log-linear form:

$$lnY = lna+b1lnX1+b2lnX2+b3lnX3+b4lnX4+b5lnX5+b6lnX6+b7lnX7+b8lnX8+b9lnX9+b10lnX9+U$$

Table 1: Estimation of Variables with Expected Sign for Fish Production

S.N	Variables Name	Variable Sign	Measurement Scale	Expected Sign	Literature References
1.	Human labor cost	*X1*	BDT/ Hectare	+	Bristy et al., 2021
2.	Fingerling cost	*X2*	BDT/ Hectare	+	Ghose, 2014
3.	Feed cost	*X3*	BDT/ Hectare	+ or -	Ghose, 2014
4.	Manure cost	*X4*	BDT/ Hectare	+	Islam et al. (2019)
5.	Fertilizer cost	*X5*	BDT/ Hectare	+ or -	Eckstein et al. (2021)
6.	Lime cost	*X6*	BDT/ Hectare	+ or -	Manik, 2023
7.	Pesticide cost	*X7*	BDT/ Hectare	+	Manik, 2023
8.	Water supply cost	*X8*	BDT/ Hectare	+	Sunny et al., 2021
9.	Electricity cost	*X9*	BDT/ Hectare	-	Shamsuzzaman (2017)
10.	Environmental Knowledge	*X10*	Index Score	+ or -	Abdullah et al. (2022)
Dependent Variable: Hectare wise Production					

Source: Authors Own compilation 2025

2 Efficiency of Resource Allocation

In order to test the efficiency, the ratio of Marginal Value Product (MVP) to the Marginal Factor Cost (MFC) for each input was computed and tested for its equality to 1.

$$\text{ERA}: \frac{\text{MVPx}}{\text{MFCx}} = 1$$

From the above equation, it is seen that the marginal productivity of a particular resource represents the addition to gross returns in value term produced by an extra 1 unit of that resource, while other inputs are held constant. The most dependable, perhaps the most useful, estimate of MVP is attained by taking fish resources (Xi) value as gross return (Y) at that geometric means (Dhawan and Bansal, 1977).

Marginal Factor Cost (MFC) of all the inputs are articulated in terms of additional BDT spent for specific inputs in farming. In the present study, Marginal Factor Cost was the normal price of different variable inputs used. The ratio of MVP and MFC are equivalent to unity designates that the resource is efficiently used. When the ratio of MVP and MFC are more than unity, it infers that the resource is under-utilized, that is bad sign for farmers. The ratio of MVP and MFC are proved less than unity, designates that the resource is over-used for farmers. (Yotopoulos, 1967).

Table 2: Estimation of Environmental Knowledge Index (EKI)

Indicators	Scoring Index	Required Score
Knowledge about Greenhouse Effect	1 to 5	Very Low=1, Low=2, Moderate = 3, Good=4, Very Good=5
Knowledge about toxic creation from pond	1 to 5	
Awareness about Eco-friendly Fish-feed	1 to 5	
Responsible Knowledge of Carbon Emission from Pond	1 to 5	***(Minimum Score=6 and Maximum Score =30)***
Knowledge about Environmental-friendly Fertilizer usage	1 to 5	
Knowledge about Water Wastage Management	1 to 5	

Source: Authors Own compilation 2025

Results

Profitability is the chief aim of any farmer. In order to earn a respectable economic return, production cost becomes an important factor and accordingly it contributes a dominant role for farmers. Costs and returns are valued on the basis of authentic market prices affected by the fish-farmers.

Table 3: Per Hectare Costing of Producing Different Categories of Fishes

(Hectare wise BDT Costing per Year)

Cost items	Marginal farmers	Small farmers	Medium farmers
Variable cost			
Human labor	4,67,130	4,25,228	3,83,450
	(20.36)	*(14.86)*	*(11.45)*
Feed	11,50,214	15,80,567	18,62,513
	(62.05)	*(70.45)*	*(74.45)*
Fingerlings	1,60,233	1,70,487	1,75,502
	(8.67)	*(6.97)*	*(6.36)*
Fertilizer	18,908	15,737	16304
	(0.94)	*(0.58)*	*(0.58)*
Manure	75	65	59

Cost items	Marginal farmers	Small farmers	Medium farmers
	(0.01)	*(0.01)*	*(0.01)*
Lime	13,041	7,277	9600
	(0.67)	*(0.38)*	*(0.34)*
Pesticide	8,200	4365	7534
	(0.40)	*(0.16)*	*(0.24)*
Electricity	10,660	12,500	13618
	(0.54)	*(0.44)*	*(0.51)*
Fixed cost			
Land use cost	40,290	42,014	39,627
	(1.68)	*(1.46)*	*(1.36)*
Interest on Operating Cost	94,373	1,05,725	1,22,252
	(4.68)	*(4.69)*	*(4.70)*
Total	**19,63,124**	**23,63,965**	**26,30,459**
	(200)	(200)	(200)

Source: Author own compilation 2025

From the above table, it is measure that the costing pattern is divided for two parts, fixed cost and variables cost. Most of the portion has covered by human-labor that varies from three categories of farmers. Marginal farmers spend most money for human labor purposes, and medium farmers' costs fewer below compared than marginal farmers. A big portion has been spent for feed-purchasing purchases for small and medium famers, which uplifts their costing pattern. The cost of fingerlings varies from farm size and fish quality, where marginal famers faces huge costing for fingerlings. The second portion denotes fixed cost, where land use and interest over operating cost are two parts, mostly marginal farmers bear most fixed cost as interest bearing factors.

Table 4: Multiple Regression Model to measure the Impact of Independent Variables

Variables Name	Variable Sign	Coefficient Value	t Value
Constant	2.698	1.890	0.872
Human labor cost (X_1)	0.214 **	0.097	2.201
Fingerlings cost (X_2)	0.009	0.105	0.086
Feed cost (X_3)	0.651 ***	0.149	9.987
Manure cost (X_4)	0.081 *	0.040	1.775
Fertilizer cost (X_5)	-0.056	0.082	-0.919
Lime cost (X_6)	0.079	0.049	1.674
Pesticide cost (X_7)	0.009	0.032	0.281
Water supply cost (X_8)	0.135 **	0.065	2.077
Electricity cost (X_9)	0.086	0.082	1.049
Environmental Knowledge (X_{10})	*0.045**	0.033	1.85
F-value (N = 60)	*27.20*		
R^2	*0.94*		
Returns to scale	*1.72*		

Source: Author own compilation 2025

From the above table, it is known that Human-labor Costing, Manure Cost, Feed-Cost, water

supply cost has significant relation with fish production per hectare. If the human capital is more utilized for pond- processing, fish production will be increased will be increased at 21 percent. Secondly, Feed cost has positive connection with fish production, increasing feed-cost help to enhance fish production by nearly 65 percent, that is statically significant at 1 percent level. Thirdly, manure cost has positive connection with production, when famers launch for mixed-farming then wastage of hen-ducks mix with water, that is natural sources of protein and vitamin for fishes. Fourthly, water-supply has positive and significant connection with production, proper water-supply leads to enhance fish production per hectare. Fifthly, most farmers have no idea about environmental friendly fish-feed supply, that is called as green-feed for fishes, environmental knowledge is one of the emerging issues for fish-production, it is highly connected with basic environmental knowledge which is depicted on table no 2 in this research. When all over the world is trying to achieve sustainable goals within 2030, it is our core duty to establish the practice of eco fish-feed production and consumption. It is noticed that environmental knowledge also helps to ensure the growth of fish production per hectare. It is also statistically significant.

Conclusion

Sustainable fish-production is one of the challenging issues for rural famers, but fish marketing and supply are two well connected factors that help to ensure profit margin at maximum level. Most of the cases local fish-farmers do not grab the fragrance of profit properly where it grabs by middlemen who controls farmers and final consumers badly. By studying the fish marketing channel and their cost and profit margins some recommendations are drawn which are given in below. Fish is highly perishable product that is needed proper preservation facilities for marketing. It is needed to move fishes distance place for marketing. So transportation and shipment facilities should be improved. It is the basis requirement of establishment of sufficient ice factory adjacent to culture ground. It is necessary to introduce modern wholesaling and retailing facilities. To improve the hygienic conditions of landing centers and markets. Keep the constant price of fish by government. Avoiding middlemen during fish marketing is key factors for improving market-share of farmers. Local, National and International NGOs and also Government should provide technical knowledge and credit sources for the agents of fish marketing. Ensure better marketing and distribution of fishes. With the increasing of middleman, the market share of fishermen decreases and the consumer price increases. The result shows that there is huge gap between the farmed price and the consumer level price. This indicates the longer the marketing channel, the lesser the share of the fisherman and higher the marketing margins. Alternatively the shorter the marketing channel, the higher the share of the fisherman and lower the marketing margins. To develop and improve the fish marketing channel, the unnecessary and exploitative middleman should be eliminated. So, government and public-private relationship is essential to improve the existing fish marketing system.

Funding

This study received no specific financial support.

Competing interests

The authors declare that they have no competing interests.

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