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An Economic Study of Small-Scale Koi (Anabas Testudineus) Fish Farming in Some Selected Areas of Greater Mymensingh District

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Abstract

The present study attempts to determine the costs and returns of small-scale Koi fish farming and resource use efficiency under different categories of farmers in some selected areas of greater Mymensingh district. Data and information were collected for the year 2011. In total, 60 Koi fish farmers were selected, of which 30 were small farmers and 10 and 20 were marginal and medium farmers, respectively. Total cost, gross return, gross margin, net return, and benefit cost ratio were used for economic analysis. Total cost, gross return and net return of Koi fish production were estimated at Tk. 2103091, 2736869 and 601245/ha, respectively. Benefit cost ratio was found to be 1.30. The Cobb-Douglas production function model was used to estimate the values of co-efficients and related statistics of production function of Koi fish culture. The co-efficient of human labour, feed, manure and water supply were statistically significant. Other co-efficients (fingerlings, fertilizer, pesticide, lime and electricity) were not statistically significant. Return to scale was found 1.09 and the value of R^2 was 0.84. Analysis of resource use efficiency indicates that more profit can be obtained by increasing efficient and judicious investment in various inputs. From the study it was evident that timely and efficient use of different inputs are most important to increase production and profitability of Koi fish farming.

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1. Introduction

Land and life are closely entwined for the farmers in Bangladesh. Regarding the endowment of water resources, Bangladesh stands in third position in the world after China and India. Bangladesh is blessed with vast fisheries resources due to favorable climatic condition and geographical location. There are a lot of rivers, estuaries, beel, lake, pond, dighis, haor baor etc., which are suitable for fish culture. The performance of the fisheries sector has an overwhelming impact on the economy of Bangladesh. Fisheries sector plays a very significant role in supplying nutrition, creation of rural employment, poverty alleviation, earning foreign exchange, and more importantly socioeconomic stability in the rural areas of Bangladesh. This sector contributes 4.51 percent of Gross Domestic Product (GDP) (GOB, 2010). The majority of freshwater fish are raised in fish ponds. In Bangladesh, total areas of pond are 362520 acres but fish are cultured in 189365 acres (BBS, 2009). Now, pond fish culture is very important for the small farmers, which can help increase the household income. *Koi* is one of the most important carpfish and successfully cultured in the fish ponds, which is newly introduced in Bangladesh. However, per capita fish consumption increased from 42.10 gm in 2005 to 49.41 gm in 2010 (HIES, 2010). To meet these requirements, *Koi* culture is incomparable as it is a quick growing and high productive fish. The climate, water and soil condition of our country have proved totally satiable for *Koi* culture. It can withstand harsh environmental conditions such as low oxygen, wide range of temperatures and other poor water conditions. *Koi* fish also contain high amount of protein, fat, carbohydrate, mineral, iron, calcium etc. (Khan, 2004). *Koi* fish can be cultivated at short period with a high density and at least two harvests can be made in a year. At present, fish producers in our country understood the positive effect of scientific aquaculture and they already adopted a number of improved technologies for increasing fish production through pond fish culture. By adopting scientific method, production of *Koi* fish has increasd and it was exported in international market. In the year of 2008-09 total amounts of 75286 metric tons of live fish (Koi, Singhi, Magur) worth Tk. 4.83 million were exported in different countries of the world (BBS, 2008). Therefore, *Koi* fish culture in the pond is a new dimension of scientific culture in Bangladesh.

Since *Koi* fish culture is a new technology, very few studies on it could be found in this regard. Hasan et al (2010) conducted a preliminary investigation into the growth, survival and production of Thai *Koi* (*Anabus testudineus*) and observed that Saudi Bangla fish feed and Mixed feed provided maximum profit compared to other feeds. Prithwiraj (2005) examined the effects of different management regimes on the feeding habits and food selection of *koi* carp (*Cyprinus carpio* var.

koi L.) larvae. He found that *koi* larvae avoided phytoplankton and preferred cladocerans, an important source of natural food in all the regimes. However, studies on economic performance of *Koi* fish farming are not available. Therefore, much work is required to enhance empirical knowledge and understanding of economic analysis of *Koi* fish farming. Accordingly the present study was conducted to determine the profitability and economic efficiency of small-scale commercial *Koi* fish farming in Bangladesh.

2. Methodology

This study was conducted at four Upazilas namely Phulpur, Netrokona Sadar, Mohanganj and Kendua from two districts namely Mymensingh and Netrokona. A purposive sampling technique was followed. In total 60 farmers were selected, of which 10 were marginal (0.02 to 0.40 ha) and 30 and 20 were small (0.41 to 1.01 ha) and medium farmers (1.02 ha and above), respectively. Data and information were collected for the year 2011.

Tabular technique was used to determine the profitability of *Koi* fish farming. Statistical analysis was applied to measure resource use efficiency of *Koi* fish culture. Cob-Douglas production 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:

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} X_8^{b8} X_9^{b9}e^{u}$$

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

$$\ln Y = \ln a + b_1\ln X_1 + b_2\ln X_2 + b_3\ln X_3 + b_4\ln X_4 + b_5\ln X_5 + b_6\ln X_6 + b_7\ln X_7 + b_8\ln X_8 + b_9\ln X_9 + U$$

Where,

Y	=	Gross return (Tk./ha);	X_5	=	Fertilizer cost (Tk./ha);
X_1	=	Human labour cost (Tk./ha);	X_6	=	Lime cost (Tk./ha);
X_2	=	Fingerling cost (Tk./ha);	X_7	=	Pesticide cost (Tk./ha);
X_3	=	Feed cost (Tk./ha);	X_8	=	Water supply cost (Tk./ha);
X_4	=	Manure cost (Tk./ha);	X_9	=	Electricity cost (Tk./ha);
ln	=	Natural logarithm;	a	=	Intercept;

(b_1...b_9)= Coefficients of respective variables; and

U = Error term.

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.

i.e. $\frac{MVPx_i}{MFCx_i} = 1$

The marginal productivity of a particular resource represents the addition to gross returns in value term caused by an additional one unit of that resource, while other inputs are held constant. The most reliable, perhaps the most useful, estimate of MVP is obtained by taking resources (X_i) as well as gross return (Y) at their geometric means (Dhawan and Bansal, 1977). Marginal Factor Cost (MFC) of all the inputs are expressed in terms of additional taka spent for providing individual inputs. In the present study, Marginal Factor Cost was the average price of different variable inputs used. The ratio of MVP and MFC equal to unity indicates that the resource is efficiently used. When the ratio of MVP and MFC is more than unity, it implies that the resource is under-utilized. The ratio of MVP and MFC less than unity, indicates that the resource is over-used (Yotopoulos, 1967).

3. Profitability and Economic Efficiency of Small Scale Commercial *Koi* Fish Farming

Profitability is the main aim of any farmer. In order to earn a respectable economic return, production cost becomes an important factor and accordingly it plays a dominant role in the decision making process of the farmers. Costs and returns were calculated on the basis of actual market prices paid by the farmers. All costs and returns were calculated for the duration of one year of *Koi* fish production, including from pond preparation to marketing of fish.

Production cost: The cost of production included different variable cost items like human labour, fingerlings, feed, fertilizer, manure, lime, pesticide, watering and electricity. Fixed cost included land use cost and interest on operating capital of *Koi* fish production. Per hectare cost of producing *Koi* fish in different categories of farmers amounted to Tk. 1802124, 2189246 and 2474919 for marginal, small and medium farmers, respectively, and on average it was Tk. 2103091 (Table 1).

Economic return: Gross returns are the money value of fish produced. This is calculated by multiplying the total amount of fish produced by their respective market price. Table 2 represents various farm returns of *Koi* fish farmers. Gross returns for marginal, small and medium farmers were estimated at Tk. 2347846, 2890242 and 3457805, respectively, and gross margins for the same farmers were Tk. 660385, 835735 and 1132765, respectively. However, their net returns were estimated at Tk. 545722, 700996 and 982886, respectively. Again, the undiscounted benefit cost ratios came out to be 1.30, 1.32 and 1.39 for marginal, small and medium farmers, respectively. It is evident from the results that *Koi* fish culture is a profitable business.

Factors affecting *Koi* fish production: The contribution of specified factors to the production of *Koi* fish can be seen in Table 3. The results showed that out of nine coefficients, eight have the positive sign. The positive sign indicates that using more of these inputs in *Koi* fish production could increase return to some extent. The coefficient of manure was 0.071, which was statistically significant at 1% level. This indicates that keeping other factors constant, a one percent increase in the cost of using manure would lead to an increase in the gross return by 0.071 percent. The coefficients of human labour and water supply were 0.214 and 0.135, which were statistically significant at 5 % level. It means that a one percent increase in the cost of human labour and water supply would lead to an increase in the gross return by 0.214 and 0.135 percent, keeping other factors unchanged. However, the coefficient value of feed was 0.551, which was significant at 10 %

Table 1 : Per hectare cost of producing Koi fish in different categories of fish farmer

(Tk./ha/year)

Cost items	Marginal farmers	Small farmers	Medium farmers
Variable cost			
Human labour	367130	325228	283489
	(20.36)	(14.86)	(11.45)
Feed	1118214	1542567	1842513
	(62.05)	(70.45)	(74.45)
Fingerlings	156233	152487	157502
	(8.67)	(6.97)	(6.36)
Fertilizer	16908	12737	14304
	(0.94)	(0.58)	(0.58)
Manure	29	33	43
	(0.01)	(0.01)	(0.01)
Lime	12041	8277	8537
	(0.67)	(0.38)	(0.34)
Pesticide	7246	3465	6034
	(0.40)	(0.16)	(0.24)
Electricity	9660	9713	12618
	(0.54)	(0.44)	(0.51)
Fixed cost			
Land use cost	30290	32014	33627
	(1.68)	(1.46)	(1.36)
Interest on	84373	102725	116252
operating cost	(4.68)	(4.69)	(4.70)
Total	1802124	2189246	2474919
	(100)	(100)	(100)

Note: Figures within parenthesis indicate percentage of total cost.

Table 2 : Per hectare costs and returns of Koi production

(Amout in Tk./ha/year)

Particulars	Farm categories			
	Marginal farmers	Small farmers	Medium farmers	All farmers
Yield (Kg)	19222	23122	27881	22179
Gross Returns (GR)	2347846	2890242	3457805	2736869
Total Variable Cos t (TVC)	1687461	2054507	2325040	2003474
Total Fixed Cost (TFC)	114663	134739	149879	132150
Total Cost (TC)= (TVC+TFC)	1802124	2189246	2474919	2103091
Gross Margin(GM) = (GR-TVC)	660385	835735	1132765	733395
Net Returns (NR) =(GR-TC)	545722	700996	982886	633778
BCR (Undiscounted) (GR/TC)	1.30	1.32	1.39	1.30

level. This implies that keeping other things constant a one percent increase in feed cost would lead to increase in gross returns by 0.551 percent. Other variables (fingerlings, fertilizer, lime, pesticide and electricity) were not statistically significant.

The coefficient of multiple determination, R^2, was 0.84, which indicates that about 84 percent of return from *Koi* fish culture was explained by the explanatory variables included in the model and it also indicates that excluded variables accounted for only 16 percent of the variation in *Koi* fish production. The F-value of *Koi* fish production was highly significant at 1 percent level. Highly significant F-value implied that the variation in return of *Koi* fish depends upon mainly the explanatory variables included in the model. There was also increasing returns to scale (1.09) which means that if all the inputs specified in the production function were increased by 1 percent, gross return of *Koi* fish would increase by 1.09 percent.

Resource use efficiency: From Table 4, it can be seen that none of the Marginal Value Products of inputs were equal to one. This inequality indicates that the farmers in the study area have failed to show their efficiency in using the resources.

In the case of manure the ratio of MVP and MFC were greater than one and positive. It indicates that the *Koi* fish farmers have not availed themselves of the

Table 3 : Estimated values of coefficients and related statistics of Cobb-Douglas production function for gross return of Koi fish

Factors of production	Co-efficient	Standard Error	t-value
Constant	1.698	1.970	0.862
Human labour cost (X_1)	0.214 **	0.093	2.301
Fingerlings cost (X_2)	0.009	0.105	0.086
Feed cost (X_3)	0.551 ***	0.049	9.987
Manure cost (X_4)	0.071 *	0.040	1.775
Fertilizer cost (X_5)	-0.059	0.072	-0.819
Lime cost (X_6)	0.074	0.047	1.574
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
F-value (N = 60)	28.754		
R^2	0.84		
Returns to scale	1.09		

Note: '***', '**' and '*' indicates significant at 1%, 5%, 10% level.

opportunities to the fuller use of various inputs. So, there were ample opportunities for farmers in the study areas to increase output per hectare by using more of these inputs. That is, more profit could be obtained by increasing investment in those inputs.

In the case of human labour, fingerlings, feed, lime, pesticide, water supply and electricity ratios were positive but less than one, which implies too much use of these resources. In the case of fertilizer the ratio was negative, which implies that excessive use of these inputs for *Koi* fish production leads to reduction of gross return. Hence, these inputs were not efficiently used by the sample farmers.

4. Conclusion

Koi fish production in the study areas was highly profitable. Farmers received higher return on their investment. *Koi* fish production can be increased by improving the production technology and knowledge in existing pond fish culture. If proper incentives are given, the increased production of *Koi* fish could help increase income, employment generation and poverty alleviation of the respective farms. Moreover, the demand for *Koi* is increasing both at home and abroad. Therefore, after meeting local consumption, it can be exported in the international market by which a lot of foreign currency can be earned. The farmer has to be

Table 4 : Marginal Value Products (MVP) of Koi fish production and resource use efficiency

Variables	Coefficient	GM	MVP	MFC	Efficiency
Gross return (Y)	-	323862.88	-	-	-
Human labour (X_1)	0.214	29794.63	2.33	210.15	0.01
Fingerlings (X_2)	0.009	15006.72	0.19	0.56	0.34
Feed (X_3)	0.551	178151.69	1.002	38.90	0.03
Manure (X_4)	0.071	7987.97	2.302	0.41	5.61
Fertilizer (X_5)	-0.059	12214.40	-0.82	23.40	-0.04
Lime (X_6)	0.074	10830.11	1.764	10.89	0.16
Pesticide (X_7)	0.009	4242.16	0.867	20.88	0.03
Water supply (X_8)	0.135	1589.87	27.50	50.00	0.55
Electricity (X_9)	0.086	10143.80	2.72	3.90	0.70

Note: GM = Geometric Mean

more conscious for using their inputs in a manner that will enable them limit the total cost and gain more profit. Extensive programme should be undertaken by the Government and concerned agencies to train up the fish farmers about updating the scientific knowledge of *Koi* fish production.

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