An empirical study on income and efficiency of pond fish and nursery fish production in some selected areas of Pabna, Bangladesh

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Abstract
The study was designed to determine the costs, returns and relative profitability of pond fish and nursery fish production. In order to attain this objective, a total of 70 producers: 35 producing pond fish and 35 producing nursery fish were selected on the basis of purposive random sampling technique from 6 villages under two Upazilas (Sujanagar and Santhia) of Pabna district. It was estimated that per hectare per year gross cost of pond fish production was Tk 65,918 while gross return and net return were Tk 91,707 and Tk 25,789 respectively. Per hectare per year gross cost of nursery fish production was Tk 87,489 while gross return and net return were Tk 1,39,272 and Tk 51,783 respectively. The findings revealed that nursery fish production was more profitable than pond fish production. Cobb-Douglas production function was applied to realize the specific effect of the factors on pond fish and nursery fish production. It was observed that most of the included variables had significant impact on pond fish and nursery fish production. Out of five variables included in the function, all the variables had positive impact on return from pond fish production but stock value of pond, material cost and pond area had positive impact on return from nursery fish production.

Key words: Economic efficiency, Nursery pond

Introduction

Fisheries sector plays an important role in nutrition, employment and foreign exchange earnings in the economy of Bangladesh. Most of the people in this country depend on fish as main source of animal protein. About 63 percent of animal protein is supplied by fish alone (DoF 2002). It has been estimated that about 1.3 million people are directly employed in this sector. Another 12 million people indirectly earn their livelihood from fisheries related activities. Frozen shrimp, fish and fishery products occupy the third position in the country's exports (5.77% of total foreign exchange earning). In 2000-2001, fisheries sector contributed 5.3 percent to the total GDP of the country (DoF 2002). The country's total production of fish was 17,81,057 tones in 2000-2001 of which 14,01,560 tones were from inland sources and 3,79,497 tones from the marine sources. The growth rate of the production during the last decade on an average

was 7.11 percent. However, the present growth rate is quite encouraging which, in fact, is 7.20 percent (DoF 2002).

In Bangladesh, there are two sources of fisheries- inland fisheries and marine fisheries. The contribution of the inland fisheries is 78.69 percent to the total catch while the marine's contribution is 21.31 percent. Of the different inland water bodies, ponds are the most important for their easy access to fish production and about 79 percent of total production of fish comes from inland sources and of this, about 40 percent comes from ponds. The total area of ponds and ditches is 2,41,500 hectares (DoF 2002). The need for fish seed production is now more increasingly felt than ever before as natural seed collection has been alarmingly depleted due to many natural and man made causes. In Bangladesh, there are about 779 private and 113 public hatcheries. The annual fish seed/fry production is about 2,20,217 kg. The stocking size of fish seed of the country comes from nurseries, both public and private nurseries. In the country, there are about 4,133 private nurseries, with an average area of 1 hectare each and 82 government nurseries covering an area of about 60 hectares. In 2000-2001, both private and public nurseries produced 5,055 million fingerlings (DoF 2002).

In Bangladesh, increased aquacultural production, mainly pond fish production can help to meet the increased domestic demand for fish (20.75 lakh ton/2.075 million tones; FFYP, 1997-2002). In order to meet the shortage of fish, the Department of Fisheries (DoF) and some Non-government Organizations (NGOs) are encouraging people to increase fish production in their surrounding water areas (pond, *haor, baor, beel* etc.). In response to government's initiative for augmenting fish production in the country, people have started to be occupied in different types of fish production activities. The two important activities are raising of fingerlings and production of table fish using different types of technologies popularised by various government and non-government agencies.

The focus of the present study is to provide information about comparative profitability of pond fish and nursery fish production. Moreover, results of production function analysis can indicate which input is used efficiently. Some studies (Islam and Dewan 1987, Khan 1996, Malek 1997, Rahman *et al.* 1997, Rahman *et al.* 1998 and Siddique 1999) were conducted on pond fish production and fish seed/fingerling production based on economic returns. In this context, the present study was aimed to determine the relative profitability and resource use efficiency of pond fish and nursery fish production.

Methodology

The study was carried out from January to November 2000 in selected areas of Pabna district. A set of interview schedules was pre-tested and developed. Data were collected from 6 villages under two Upazilas (Sujanagar and Santhia) of Pabna district. A total of 70 producers: 35 producing pond fish and 35 producing nursery fish were selected on the basis of purposive random sampling technique. In this study, a simple tabular method was followed to illustrate the whole picture of analysis. The sum, mean,

percentage, ratio, etc. were the simple statistical measures employed to show the comparative performance of pond fish and nursery fish production. Relative profitability of pond fish and nursery fish production has been determined on the basis of net return analysis.

Net return analysis

To determine the net returns from pond fish and nursery fish production, gross costs (variable and fixed cost) were deducted from gross returns. An easy principle to determine costs and return was followed to determine the profitability of pond fish and nursery fish production. For this purpose the following equation was used (Dillon and Hardaker 1993).

The equation has been applied for each of the selected producers.

$$\Pi = Pm \bullet Ym + P_b \bullet Y_b - \sum_{i=1}^{n} (Px_i \bullet X_i) - TFC \quad Where,$$

Π	=	Net return
Pm	=	Price of main product per unit
Ym	=	Total quantity of main product
P_b	=	Price of by-product per unit
Y_b	=	Quantity of by-product
Px_i	=	Price of ith input per unit for producing pond fish / nursery fish
X_i	=	Quantity of the ith input for producing pond fish / nursery fish
TFC	=	Total fixed cost
i	=	1, 2, 3, - - - - - - - - , n (number of input)

Functional analysis

To explore the effects of variable inputs both linear and Cobb-Douglas production function models were estimated initially. Data were converted to per farm basis to facilitate the analysis. The results of the Cobb-Douglas models appeared to be superior on theoretical and econometric grounds. So the Cobb-Douglas model was accepted for interpretation. Five independent variables were employed to explain the gross returns from pond fish and nursery fish production in the study areas. Regression analysis (ordinary least squares) method was used to determine the effect of these inputs. A series of regression procedures were carried out to be sure that serious multicollinearity problem did not exist. Cobb-Douglas production function analysis was done taking 35 pond fish farms and 35 nursery fish farms into account separately. The function was specified as:

$$Y = aX_{1i}^{b1} \, X_{2i}^{b2} \, X_{3i}^{b3} \, X_{4i}^{b4} \, X_{5i}^{b5} \, e^{Ui}$$

The function was linearised by transforming it into the following double log or log linear form:

$$\ln Y = \ln a + b_1 \ln X_{1i} + b_2 \ln X_{2i} + b_3 \ln X_{3i} + b_4 \ln X_{4i} + b_5 \ln X_{5i} + U_i$$

Where,

Y = Gross return from fish/fingerlings production per farm (Tk);

X_1 = Stock value of pond per farm (Tk);

X_2 = Material cost per farm (Tk);

X_3 = Labour cost per farm (Tk);

X_4 = Pond area (hectare);

X_5 = Depth of pond water (metre);

ln = Natural logarithm;

a = Intercept;

b_i = Production coefficients; and

U = Error term.

Some important inputs like feed, fertilizer and chemicals were included in the model as material input. Furthermore, few important variables like experience in pond keeping, number of ponds, duration of water etc. which might affect pond fish and nursery fish production could not be included in the model due to non-availability of appropriate data for the model.

Results and discussion

Costs and returns

Among the different cost items, cost of fish seed appeared to be the highest and represented 55 and 50 percent of total cost of pond fish and nursery fish production. The average per hectare cost per year amounted to Tk. 59,532 and Tk. 75,267 for pond fish and nursery fish production (Table 1).

Table 1. Annual cost/ha of different items required for pond fish and nursery fish production

Cost items	Pond fish production	Nursery fish production
Fish seed	32,562.79 (54.70)	37,929.59 (50.39)
Feed	5,950.98 (10.00)	2,704.22 (3.59)
Fertilizer	2,120.69 (3.56)	4,443.29 (5.90)
Human Labour	13,121.55 (22.04)	17,895.80 (23.78)
Chemicals	1,431.71 (2.40)	6,056.95 (8.05)
Miscellaneous*	4,344.38 (7.30)	6,237.46 (8.29)
Total	59,532.10 (100)	75,267.31 (100)

Source: Haque 2000 Note: Numbers in the parentheses indicate the percentage of total cost. Miscellaneous included entertainment, transportation, medicine etc.

Table 2 captures information on cost and return per hectare of pond fish and nursery fish production. Gross returns from pond fish and nursery fish production amounted to Tk.91,707 and Tk.1,39,272 respectively. Gross costs were Tk. 59,532 and Tk.75,267 per hectare of pond fish and nursery fish production. The net returns from pond fish and nursery fish production were computed at Tk. 32,175 and Tk. 64,005 per hectare. Net returns per taka invested were Tk. 0.54 and Tk. 0.85 for pond fish and nursery fish production respectively. The benefit cost ratios (BCR, undiscounted) of pond fish and nursery fish were 1.54 and 1.85 respectively, indicating that production of fish and fingerlings was profitable. A comparison of the net returns from production of pond fish and nursery fish suggested that the net return of nursery fish was higher than that of pond fish.

Table 2. Per hectare annual cost and return from pond fish and nursery fish production

Measures	Pond fish production	Fish nursery operation
Gross return (Tk/ha)	91,706.61	1,39,272.20
Gross cost (Tk/ha)	59,532.10	75,267.31
Net return (Tk/ha)	32,174.51	64,004.89
Net return per Taka invested	0.54	0.85
Benefit cost ratio (BCR)	1.54	1.85

Source: Haque 2000

Factors affecting pond fish and nursery fish production

Fish and fingerlings production in ponds results from the effects of the various inputs employed in the production process. Inputs used in any kind of production may be classified broadly into material inputs and labour inputs. Furthermore, in pond operation there are some inherent characteristics of pond environment and factors that affect its production such as pond area, depth of pond water and these factors can be employed to explain the variation in output of ponds. Accordingly, some crucial inputs have been included to explain the variation in productivity of fish ponds.

Interpretation of results

Estimated values of coefficients and related statistics of the Cobb-Douglas production function for pond fish production and fish nursery operation are shown in Table 3. From the table, the following features emerge:

The function fitted well for pond fish and nursery fish production as indicated by F-values and R^2. The coefficients of multiple determination, R^2 were 0.897 for pond fish

and 0.916 for nursery fish production. R^2 of 0.897 for pond fish indicated that variables included in the model succeeded in explaining about 90% of the total variations in the value of pond fish. On the other hand, R^2 of 0.916 indicated that about 92% variations in output of nursery fish was explained by the explanatory variables included in the model. The F-values of the two equations were highly significant at 1% levels implying that all the included explanatory variables were important for explaining the variations in pond fish and nursery fish output. The sum total of all the production coefficients (production elasticities) of the equations for pond fish and nursery fish production were 1.285 and 0.869. This indicated that the production function exhibited increasing returns to scale for pond fish production while it indicated decreasing returns to scale for nursery fish production.

Interpretation of Coefficients for Individual Variables

Stock value of pond (X_1): The regression coefficients of stock value of pond were positive for pond fish and nursery fish farm and significant at 1 percent and 5 percent levels respectively indicating that each one percent increase in the cost of fry and fingerlings, keeping other factors constant, would increase gross returns by 0.226 and 0.393 percent respectively.

Table 3. Estimated values of coefficient and related statistics of
double-log production function model

Explanatory variables	Pond fish production	Nursery fish production
Intercept	4.936	8.212
Stock value of pond (X_1)	0.226***	0.393**
	(0.080)	(0.196)
Material cost (X_2)	0.293**	0.314*
	(0.144)	(0.178)
Labour cost (X_3)	0.226**	-0.377***
	(0.100)	(0.142)
Pond area (X_4)	0.404**	0.699**
	(0.172)	(0.270)
Depth of pond water (X_5)	0.136	-0.160
	(0.207)	(0.322)
R^2 (adjusted)	0.897	0.916
F	60.256***	74.921***
Returns to scale ($\sum$ bi)	1.285	0.869

Note: Figures in the parentheses indicate standard error.
*** Significant at 1% level. ** Significant at 5% level. * Significant at 10% level.

Material cost (X_2): The coefficients of material cost were positive for pond fish and nursery fish farm and significant at 5 percent and 10 percent levels respectively. It

revealed that each one percent increase in the material cost, keeping other factors constant, would increase gross returns by 0.293 and 0.314 percent respectively.

Labour cost (X_3): The regression coefficient of human labour cost was positive for pond fish production and significant at 5 percent level indicating that one percent increase in cost of this input, keeping other factors constant, would increase the gross return of pond fish production by 0.226 percent. On the other hand, the coefficient of human labour cost was negative for nursery fish production and significant at 1 percent level, which implied the indiscriminate and excessive use of this input resulting in inefficiency.

Pond area (X_4): The coefficients of pond area were positive for pond fish and nursery fish production and significant at 5 percent levels. It revealed that each one percent increase in pond area, keeping other factors constant, would increase gross returns by 0.404 and 0.699 percent respectively.

Among the inherent variables, depth of pond water has no significant impact on pond fish and nursery fish production.

Results of the regression coefficients suggest that most of the variables included in the production function were significant in explaining the gross returns from pond fish and nursery fish production. The coefficients of stock value of pond, material input, labour cost and pond area were highly significant for both the practices.

Conclusions

The study reveals that nursery fish production is more profitable than pond fish production. The results of the study indicate that both pond fish and nursery fish production can be increased by efficient reallocation of factor inputs. It is evident from regression coefficients that stock value of pond, material input, labour cost and pond area of both the enterprises emerged as crucial factors. In the case of nursery fish production, labour cost demonstrated negative coefficient, which implied the indiscriminate and excessive use of the resource resulting in inefficiency. It may be suggested that the producers have scope to attain full efficiency by reallocating the resources in both the practices.

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