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Economics of pond fish culture in some selected areas of Bangladesh

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Abstract
A simple costs and return analysis was done to determine the profitability of pond fish culture in three selected thanas namely Nertakona Sadar, Purbadhala and Kendua under Netrakona district. Cobb-douglas production function model was used to estimate the contribution of key variables to the production process of pond fish culture. It was found that cost of pond fish production was Tk. 10,103/ha/yr and the per hectare fish yield was 943 kg/yr and the average gross and net return were Tk. 49,515 and Tk. 39,412 respectively. It was found that medium and small farms had the higher yield because of efficient use of production inputs compared to large farms. It was also observed that ownership of pond, number of species and human labour had negative impact on pond fish output, while depth of pond water, farm size, fish seed, fertilizer and artificial feed had significant positive effects on pond fish output.

Key words: Fish culture, Economics

Introduction

Pond fish production can be increased through introduction of efficient management and scientific aquaculture. Application of manure, fertilizer, quality feeds and aeration can further increase the production to 9,000 kg/ha/yr while from unfertilized pond, it usually does not exceed 500 kg/ha/yr (MPO 1984). On the other hand, socioeconomic studies on the pond fish farming seemed urgently needed to assess the profitability of pond fish production, to estimate the contribution of key variables of fish production practices to the farm output. The results of this study will be helpful to the farmers, extension workers, farm management researchers as well as to other relevant persons to generate policy alternatives for inland fish culture mainly pond fish culture in Bangladesh.

Materials and methods

In total 48 stocking ponds, 16 from each of the selected thanas namely Netrakona Sadar, Purbadhala and Kendua of Netrakona district of Bangladesh, were selected for the study. Fish pond with different types of cultural and management practices, such as i)

traditional practices, ii) improved traditional practices, iii) semi-intensive aquaculture and of different sizes of farms (small, medium, large) were included in the sample. Both tabular and statistical analysis were used in this study. Statistical analysis was used to show the effect of input use and other related factors of ponds fish farming.

To determine the effects of variable inputs, two forms of production functions were initially estimated for pond fish culture. These were liner and Cobb-Douglas forms. Finally, Cobb-Douglas production function was chosen on the basis of a best fit and significant result on output. Eight variables were taken into account to explain the pond fish production in the study area. Regression analysis (Ordinary least square method) was used to determine the effect of this inputs. Care was taken to see that the chosen variables are not multicolinear.

The general model in multiple regression form takes the following stage:

$Y = ax_1^{b1}x_2^{b2}$----------x_8^{b8}

or $\text{Log } Y = \text{Log } a + b^1\text{Log}x_1 + b^2\text{Log}x_2 +$----------$+b^8\text{Log}x_8$

Where Y = Gross value of output (Tk/ha)

X_1 = Cost of fry and fingerlings (Tk/ha) X_2 = Cost of fertilizer (Tk/ha)

X_3 = Cost of feed (Tk/ha) X_4 = Cost of human labour (Tk/ha)

X_5 = Pond size (Hectare) X_6 = Pond ownership

X_7 = Stocked species number X_8 = Depth of pond water (Meter)

a = Constant or intercept value (Tk/ha) b_i = Production co-efficient to be estimated

i = 1,2,3,----------,8.

Results and discussion

Cost of fish production

The items of cost of pond fish production for the selected locations are presented in Table 1. All these costs were counted for one production year. From the table, it appears that per hectare cost was the highest in Purbadhala (Tk. 11, 844/ha) due to high human labour cost and the lowest in Netrakona Sadar (Tk. 9341/ ha) and the average cost for all locations was Tk.10,103/ha/yr.

Table 1. Itemized costs of pond fish production per hectare per year according to locations

Cost items	Netrakona Sadar (Tk)	Purbadhala (Tk)	Kendua (Tk)	All locations	
				Total cost (Tk)	%of total cost
Material input cost	4,625	11,161	5,071	6,308	62.44
-Fish seed	4,948	4,786	5,478	5,386	53.31
-Fertilizer	489	478	481	482	4.87
-Artificial feed	608	288	495	440	4.36
-Human labour	3,058	4,235	3,843	3,795	37.56
Total costs	9,341	11,844	11,631	10,103	100.00

According to farm size groups, the items of cost of pond fish production per hectare in the selected areas are present in Table 2. From the table it appears that medium farm incurred the highest cost (10843 Tk/ha) and the small farms incurred the lowest cost (Tk. 8656/ha). Table 2 reveals that total materials cost comprised the highest amount in all the sampled areas i.e. 62.44 percent of the total cost and the fish seed stocking cost was the maximum i.e. 53.31 percent of the total costs. From Table 2 it can be seen that the material cost was the highest i.e. Tk. 7,622 per hectare in medium farm followed by small and large farms i.e. Tk. 6,913 and Tk. 4,274/ha, respectively. Per hectare cost of stocking of fry and fingerlings and fertilizer followed the same trend. But per hectare cost of artificial feed used in ponds was maximum in medium farms followed by large and small farms.

Table 2. Itemized costs of pond fish production per hectare per year according to farm size

Cost items	Small farm (Tk)	Medium farm (Tk)	Large farm (Tk)	All farms	
				Total cost (Tk)	%of total cost
Material input cost	6913	7622	4274	6308	62.44
-Fish seed	6213	6596	3394	5386	53.13
-Fertilizer	476	573	443	482	4.77
-Artificial feed	224	513	437	440	4.36
Human labour (Tk)	1743	3221	5466	3795	37.56
Total costs	8,656	10,843	9,740	10,103	100.00

Human labour cost per/ha was maximum in Purbadhala (Tk. 4,235) followed by Kendua (Tk. 3,843) and minimum in Netrakona Sadar (Tk. 3,058) and average human labour cost per hectare for all locations was Tk. 3,795 and the amount represented 37.56 percent of total cost . According to farm size per hectare labour cost was maximum in large farm i.e. Tk. 5,466 followed by medium and small farms i.e. Tk. 3,221 and Tk. 1,743, respectively.

Returns from the fish pond

Farm returns can be measured items of yield, gross return and net return. Per hectare costs and returns of pond fish production in different location are presented in Table 3. From the table, it can be seen that per hectare gross returns and net returns for all locations were Tk. 49,515 and Tk. 39,412, respectively. In the study areas, yield per hectare was maximum in Netrakona Sadar (964 kg) as expected, the net return was also the highest in Netrokona Sadar.

Table 3. Per hectare yearly costs and returns of pond fish production according to location

Locations	Yield (Kg)	Gross return (Tk)	Total cost (Tk)	Net return (Tk)
Netrakona Sadar	964	51,631	9,341	42,290
Purbadhala	935	46,659	11,844	34,815
Kendua	935	51,420	11,631	39,789
All Locations	943	49,515	10,103	39,412

Per hectare costs and returns of pond fish production according to farms size groups are presented in Table 4 and it is evident from the table that a higher investment on pond fish production yielded, as expected, higher gross returns as well the highest in medium farms i.e. Tk. 52,404 and Tk. 41,561, respectively and the lowest in large farms i.e. Tk. 45,855 and Tk. 36,115 respectively. The results presented in Table 4 clearly indicate that the pond fish culture is a profitable business, but there is a difference in profitability among different groups of farmers. It can be seen from Table 4 that the medium farmers obtained highest profit from pond fish culture. In another word, the field level performances of the owners of medium farms seem to be better than those of the small and large farms in terms of per hectare yield, gross returns, net returns and also considering net returns per invested Taka together with benefit-cost ratio (un discounted measure). As a result, the owners of the pond perhaps manage their pond more effectively and efficiently. The results also imply that at least a required standard size of pond is needed to minimize costs is to maximize the net return.

Table 4. Per hectare yearly costs and returns of pond fish production according to farm size

Size of farm	Yield (Kg)	Gross returns (Tk)	Total costs (Tk)	Net returns (Tk)
Small	873	48,982	8,656	40,326
Medium	1004	52,404	10,843	41,561
Large	891	45,855	9,740	36,115
All farms	943	49,515	10,103	31,412

Pond fish production and relative factors

Pond fish production is the outcome of using various combinations of the required inputs in the production process of pond fish culture. Besides these, in pond fish culture there are some inherent characteristics of pond and factors that affect its environment and production such as, age of pond, depth of pond, size of pond, pond ownership, and these factors can be employed to explain the variation of pond fish output (Islam and Dewan 1987). Similarly in this study, the materials inputs like stocking of fry and fingerlings, feed, fertilizer, human labour and inherent inputs such as: size of pond, pond ownership, depth of pond water and species number have been included to explain the variability of productivity of fish pond.

Estimated values of the coefficients and related statistics of Cobb-Douglas production function are shown in Table 5. The table reveals the following features:

Table 5. Estimated values of coefficients related statistics of Cobb-Douglas production function model

Explanatory variables	Netrakona Sadar	Purbadhala	Kendua	All locations
Intercept	4.003	7.269	2.799	7.8338
Fish seed (X_1)	-0.013	-0.59***	-0.4115***	-0.1392**
Fertilizer (X_2)	0.981*	0.108	2.3149***	0.4156*
Feed (X_3)	0.092***	0.303	0.1575	0.1102***
Labour (X_4)	0.040	0.149	0.1944	0.0664
Pond size (X_5)	-0.175	0.359***	-0.5031	0.4275**
Pond ownership (X_6)	-0.123	-0.012	-0.0630	-0.0487
Stocked species nos. (X_7)	-0.032	-0.035	-0.4854	-0.4087
Depth of pond water (X_8)	-0.061	0.250***	-0.7814	0.2770***
R^2	0.976	0.978	0.8476	0.9355
F-value	78.436*	82.484*	78.436*	86.176*
$\sum bi$	1.0974	0.9091	0.9350	0.7750

* = Significance at 1% level, ** = Significance at 5% level, *** = Significance at 10% level

The Cobb-Douglas production function fitted the data well for different location in the study area. The aggregate function performed better as well. The performance was measured by the estimated F and R^2 values. Islam (1987) also estimated a Cobb-Douglas production function to explain the productivity of fish ponds.

The coefficients of multiple determination, R^2 ranged from 0.847 in Kendua to 0.978 in Purbadhala. Considering all location R^2 was 0.935 which indicates that about 94.0 percent of the total variation of output of fish farming is explained by independent variables included in the model and it also indicates that excluded variables accounted for only about 6.0 percent of the variation in pond fish production . For this study, it was not possible to incorporate other explanatory variables due to non-availability of the required data.

The "F" values of the individual equations and the pooled equation are highly significant implying that all the included explanatory variables are important for explain the variation of pond fish production. Therefore, F values of the individual coefficients of the relevant inputs should be expected to become significant. The nature of input-output relationship is expected to be determined by the magnitude of the estimated production co-efficient of individual equation. Degrees of freedom for statistical significance of the selected production function were sufficient. The results were tested on 1.0 percent, 5.0 percent and 10.0 percent levels of significance. The summation of the production coefficients of the selected pond fish farmers indicates returns to scale.

In total there are 32 input coefficients (Table 5) and out of these, fifteen coefficients have improper (negative) sign, while the remaining 17 coefficients show positive impact on gross return. Out of 32 coefficients 2 coefficients are significant at 1.0 percent, 2 coefficients are significant at 5.0 percent and 8 coefficients are significant at 10.0 percent level of confidence. The relative contribution of specified factors affecting productivity of fish pond can be seen from the estimate of regression equation . From Table 5, it appears that the cost of fertilizer has positive effect on income. This indicates that there

is an opportunity to increase the gross returns per hectare by spending additional Taka for fertilizer. Based on all locations, it appears that the cost of fertilizer is significant at 1.0 percent level and the production co-efficient is 0.4156. From the Table 5 it also appears that the cost of fish feed is significant at 10.0 percent level and the production co-efficient is 0.1102 based on all locations. Cost of fish seed shows the negative effect on income under different selected areas.

Only in Kendua the estimated co-efficient for labour has improper sign and the value of production coefficient of labour by all location is 0.0664. This indicates that there may be over use of human labour which brings about negative impact on farm returns.

Among the inherent inputs farm size is highly significant and the production co-efficient is 0.4275 based on all locations, i.e. it contributes 0.43 percent of gross farm income for each 1.0 percent increase in pond area. Based on all sample ponds, depth of pond water is also significant and the production coefficient is 0.2770 based on all location, i.e. it contributes 0.28 percent of gross farm income for each 1.0 percent increase in the pond area.

Based on all sample ponds the co-efficient of number of ownership and stocked number of species in the pond showed improper sign. It has been indicated by many researchers that multiple ownership is one of the basic constraints to improve the pond condition and to take production decision efficiently. Therefore, this type of pond is less productive than those having single ownership. Number of species stocked for all locations shows a significant negative impact on gross farm income. Therefore, a standard level of stocking number is needed for obtaining better yield.

The summation of the production coefficients of selected pond (ignoring the different areas) i. e. the elasticity of production ($\sum b_i$) is equal to 0.7750. This means that the production function exhibits diminishing return to scale. In other words, if all the inputs specified in the function are increased by 1 percent gross return will increase by 0.78 percent . All the study areas show the diminishing return to scale in pond fish production at present market prices of specified inputs and outputs.

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