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Management and Profitability of Fish Seed Production

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Abstract

Proper management is the pre-condition of quality seed of fish hatchery. This paper examined the management strategies as well as profitability of fish seed hatchery in Bangladesh. Four fish hatchery concentrated districts has been chosen and total 56 hatcheries were randomly selected for this research. Brood stock management, feeding, water management and spawning are the main technical components of hatchery operations. Sources of brood, age, size and weight of broods are the main criteria of quality brood selection. Hormone pushed in brood at proper time and right manner is very important to get quality seed. Stocking density and proper male-female ratio in brood pond is another important determinant of hatchery management. Overall, the hatchery business is very lucrative, because on an average the spawn production was 1375 kg per farm and the net return (on the basis of total cost) was Tk.1886937, Tk. 680844 and Tk. 284444 for large, medium and small hatchery respectively.

Keywords: *Brood stock, fish seed (Spawn), management, profitability*

Introduction

Increased production of fish depends largely on availability of good quality fish seed. About two decades ago, farmers had to depend almost entirely on seeds from natural breeding grounds which supplied more than 85%of total requirement of seed (Karim and Ahsan 1989). However, due to some natural and man-made problems, fish seed collection from natural source has declined sharply. According to one estimate, collection of hatchling from natural sources decreased from more than 20,000 kg in mid eighty to less than 6,000 kg in mid-ninety. To fill in the gap in fish seed supply, the government established 113 fish seed multiplication farms (FSMFs) covering almost all districts of the country (DOF 2002). On the other hand, availability of effective breeding technologies encouraged private entrepreneurs to establish and operate fish hatcheries. In 1982, there were only three private fish hatcheries in the country. The number increased dramatically to 40 farms in 1985, 439 farms in 1994 and 860 farms in 2007 (DOF 1985, 1994 & 2007). According to the latest DOF estimate, there were 860 private hatcheries operating in the country, with hatchling production of about 457 thousand kg (Kilograms). The total number of government hatcheries were 113 which

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produced about 5 thousand kg of hatchlings in the country (DOF, 2005), but in 2007 the number of government hatcheries has decreased from 112 to 77 due to tremendous expansion of private hatchery.

Only a very few studies have examined the profitability of hatchery operation in Bangladesh and it was district basis not overall Bangladesh. This paper provides a micro-level analysis of farming environment, hatchery practices and management of fish hatchery in Bangladesh. It also examines the existing costs and returns structure on the basis of large, medium and small farms.

Methodology

This paper is the part of Carp Phase II project which conducted by jointly World Fish center , Penang, Malaysia and Bureau of Socioeconomic Research and Training (BSERT), Bangladesh Agricultural University, Mymensingh. Data were collected in 2006 for this research purpose. Four districts namely Mymensingh, Jessore, Chadpur and Bogra were chosen for this study because these four districts are most fish hatchery concentrated area of Bangladesh. Total 56 hatcheries were randomly selected (14 from each district) from four districts for the research.

Most of the farms have more than one hatching facilities of different types and sizes with various ranges of production capabilities, measurement on per hectare basis will not be appropriate because fish seed production has two stages: spawn and fry- fingerlings. Spawn is produced in the hatchery whereas fry and fingerlings are raised in the nursery and rearing ponds. Farm production and income depend on appropriate use of both hatchery and ponds. In such a situation, it is not easy to measure production on per hectare basis. Therefore, measurement on per farm basis is more accurate because each farm produces according to its capacity depending on fish seed production facilities available there. One the other hand, the spawn production depends on availability of brood stock of the farm, so calculation of cost and return per brood stock and per kg of brood stock is reasonable.

In this study tabular technique was followed to illustrate the management practices. The sum, average, gross costs and returns etc. were the simple statistical measures employed to show the performance of selected groups of fish farmers. Farm has been categorizes as small, medium and large on the basis of number of brood availability in the fish hatchery.

An easy principle to determine costs and return was followed to determine the profitability of fish seed production. For this purpose the following equation was used (Dillon and Hardaker, 1993). The equation has been applied for each of the selected producers**:**

$$\Pi = P_m * Y_m + P_b * Yb - \sum_{i=1}^{n} (Px_i * X_i) - TFC$$

Where,

Π = Net return, P_m= 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 fish seed, X_i= Quantity of the ith input for producing fish seed, TFC = Total fixed cost, i = 1, 2, 3, ..., n (number of input).

Findings and Discussion

Physical profile and technological aspects of hatchery operation

The physical components of a hatchery are hatchery building, brood pond, overhead water tank, breeding tank, circular tank, hatching jar, spawn house and deep/shallow tube well. A survey of 56 hatcheries from four locations of the country revealed the following physical properties of a hatchery establishment:

Brood stock management

An important aspect of hatchery operation is the management of brood stock. The source of the brood stock, size and weight of stock, maintenance of male-female ratio, type of brood pond including quality and depth of water, feeding of brood stock are the important considerations in maintaining good quality stock. Procurement, selection and maintenance of good quality stock have emerged to be a matter of serious concern in the brood stock management. Improper maintenance of stock has led to inbreeding of fish species which has resulted in excess supply of inferior quality seeds, resulting in less than expected yield and production of fish species. However, the exact nature and magnitude of the problem is less known and this calls for broad based investigation on the issue.

Spawning

The related consideration in seed production is proper spawning through which fish larvae are obtained. Two methods are generally followed in fertilizing the ova: natural mating of male and female in the brood tank and stripping of the brood fish. In both cases, injections are to be pushed at the right time and in the right manner. The source, size and age of the brood stock are critical determinants for obtaining good quality seed. All these technical considerations suggest that proper fish breeding requires adequately trained technicians. Empirical evidence suggests that the hatchery operators and technicians do not have requisite type and duration of training on technical aspects of hatchery operation. Operation of hatchery by non-trained personnel may have serious consequences on production of quality fish seeds. The high yield gap of fish between on-station yield trial and on-farm yield may be attributed to indiscriminate involvement of non-trained and unskilled manpower in the hatchery business.

Water management and delivery system

One of the critical determinants of proper spawning and survival of spawn is the water management and delivery system in a hatchery. Proper construction and location of an over-head tank is very important. Pumping of water into overhead tank from a reliable source is another important consideration. Inflow and outflow of water to and from circular tank, breeding tank, hatching jar and spawn house with the requisite speed of water flow are also the critical determinants of spawning and survival of spawn. It is often observed that the technical specifications are not properly followed in the construction and maintenance of hatcheries. Lack of technical skill of the hatchery operators and financial constraints are often responsible for substandard operation of fish hatcheries.

Hatchery management and genetic status of cultured fish species

There is serious concern regarding the genetic erosion of hatchery brood stock of all cultured species, resulting in slow growth,

poor survival rates and reduced resistance to diseases. There are many hatcheries in which 9-10 successive, closely related generations of Indian major carps and Chinese carps have been used for induced breeding. The Aquatic Resources Development, Management and Conservation Studies (ARDMCS) group, from a survey of practices in hatcheries, concluded that the genetic erosion of hatchery brood stock was caused mainly for improper selection of breeders and lack of monitoring and record keeping of the successive generations of brood stocks; negative selection by selling of the fast growing and large size specimens and retaining the residual stock for reproduction; repeated use of closely related stocks for generations and the consequent breeding of the fish species; crossbreeding of different geographical strains of Indian major carps and crossbreeding of numerous imported exotic carps which are selected for different traits e.g., ornamental, pond aquaculture and rice field culture.

Improvement and maintenance of genetic performance of hatchery brood stock is urgently needed not only to improve fish production and preserve biodiversity, but to create competition with the imported fish fry and thereby to reduce the risk of carrying new fish diseases into Bangladesh.

General information on hatchery infrastructure by hatchery size

Efforts were made to analyze the hatchery data on the basis of hatchery size (Large, medium and small) in order to see their relative performance in fish seed production and marketing system in Bangladesh. Overall hatchery area was observed to be 0.06 hectare and the average area of brood pond taking all farm categories together was 2.14 hectare. It is evident from the table that the large hatchery owner had on an average, more than two times and near about four times more brood pond area than those of medium and small hatchery owners respectively during the study (Table 1).

Table1. General information on hatchery infrastructure by hatchery size

Item	Large	Medium	Small	All
Hatchery area (hectare)	0.085	0.049	0.04	0.06
Brood pond area (hectare)	3.79	1.39	0.98	2.14
Sources of water and power	DTW, STW, Fuel and electricity	STW, Fuel and electricity	STW, Fuel and electricity	DTW, STW, Fuel and electricity
Distance from town (km)	2 - 3	2 - 3	2 - 3	2 - 3

General characteristics of hatchery operator

Overall average age of the respondents was found 45 years. The owners were in active age groups when people usually can exert more physical efforts for fish seed farming. All the respondents irrespective of categories had 10 years of schooling which facilitated them to follow improved fish production practices. Entrepreneurs belonging to 50s age group and 10 years of schooling were supposed to have more vigor and risk bearing ability. It is clear from the table that literacy level and training obtained and family size maintained positive trends with farm size groups which are expected in this context. Overall average family size was found to be 6.0 which is more than national average (4.9) (BBS, 2008).

Table 2. General characteristics of hatchery operator by hatchery size

Item	Large	Medium	Small	All
Age (years)	48	42	45	45
Education of schooling (years)	10.81	9.33	8.5	9.59
Experience (years)	12.43	7.8	11.05	10.7
Training obtained (%)	55	53	43	48
Family size (number)	6.86	6.27	4.9	6

Species wise brood stock and their weight by hatchery size

Almost all the hatcheries stocked Rui, Catla, Mrigel, Silver carp, Grass carp, Miror carp, raj punti and Pungas. The average number of stock of above mentioned brood species were respectively 392, 108, 380, 372, 98, 105, 603 and 361 per farm. Table 3 reveals that the share of silver barb (punti) in brood stock was the highest (23.07%) during the investigation period. Average weight per brood for Silver barb (Punti) was found almost equal irrespective of farm category (large-0.46 kg, medium-0.51 kg and small - 0.49 kg). Total weight of broods stock for large, medium and small farms were 11949 kg, 4431 kg and 2072 kg respectively and taking all farms together total weight was found 6500 kg.

Brood characteristics of the hatcheries

There are natural and artificial sources of brood fish. Natural sources means open water i.,e., beels , rivers etc. and that of artificial source means only ponds and fish farm where from the hatchery owners collect brood fish for artificial breeding purpose. In the study area about 98%hatchery owners collected their broods from artificial source. The highest age of Black carp brood species is 6.15 years and lowest age for Pabda is one (1) year. The most common size of spawning individuals of carp species is 3-5 kg. Large fishes are less suitable for hormone treatment because of the requirement of large doses of hormone and the difficulties in handling them. It appears from the study that all the species involved were of desirable weight (i.e., 3-5 kg). For most of the species first breeding age is 2-3 years except black carp where it is 6.75 years. The female-male ratios of all species are 1:1 except for black carp and Magur these are 3:1 and 7:1 respectively.

One brood fish can be used more than once in a year for breeding purpose and common frequency is 2-3 except Silver barb (Raj punti) where one brood fish could be used almost 4 times in a year. One single brood fish of any species can be used in breeding purpose normally for 3-5 years except Black carp which can be used for more than 11 years.

Overall average number of brood pond per farm was 6.68 (large 8.62, medium 6.0 and small 5.15) containing 2.14 hectare pond area (large 3.79 ha, medium 1.39 ha and small 0.98 ha) during the investigating period. Stocking density per hectare considering all farms together on an average was 1222 weighting 2995 kg as evidenced by table 3. Stocking density (no./ha & kg/ha) were found 1202 & 3153 and 1529 & 3547 and 961 & 2115 for large, medium and small farms respectively in the study locations. Hatching rate and that of mortality rate were observed to be 90%and 14%being almost similar for all categories.

Overall spawn production was estimated at 1375 kg and average price per kg of spawn

was observed to be Tk. 1367 during the study period. Spawn production relates positively with farm size in the study locations. Productions of spawn for large, medium and small farms were 2432 kg, 1022 kg and 530 kg respectively and those of prices were Tk. 1362, 1373.50 and 1367.50 during the same period.

Table 3. Brood characteristics of the hatcheries

Item	Large	Medium	Small	All
Number of brood pond (no.)	8.62	6	5.15	6.68
Area of brood pond (hectare)	3.79	1.39	0.98	2.14
Stocking density (no./ha)	1202	1529	961	1222
Number of brood stock per farm	4556	2125	942	2614
Stocking density (kg/ha)	3153	3547	2115	2995
Hatching rate (%)	91	89	85	90
Mortality rate (%)	15	14	14	14
Spawn production (kg)	2432	1022	530	1375
Price of spawn (Tk./kg)	1362	1373.5	1367.5	1367

Cost and return of the hatchery business

Cost involved in producing spawn were broadly classified into (a) variable cost and (b) fixed cost. Variable cost again includes labor cost and material input cost which contains feed, fertilizer & manure, chemicals, hormone, brood fish, fuel, plastic bag, re-excavation and others. While tools and equipment, farm building and other structure and rental value of hatchery and pond area belong to fixed cost components in present study. It is quite evident from table 4 that variable expenditure of different types was found most important in hatching fish spawn to all farm size groups constituting more than 70%while rest of cost has been incurred for fixed expenditure during the period. Material cost seems to be prime one in variable cost component sharing about 60%in large farms, 55% in medium farms and more than 53% in small farms in study locations.

Almost equal percentage (18) of variable cost has been spent on human labor by the farmers. Among other items of variable cost, expenditure on spawn feed during the year was found to be important sharing of total cost. Rental value of fish pond area was found important in fixed cost component followed by tools and equipment (7.59%) and farm structure (2.92%) during the same period. Thus total gross cost per farm in total stood at Tk. 1475112, Tk. 742561 and Tk. 453721 respectively for large, medium and small farms. Accordingly gross return per farm came to Tk. 3362049, Tk. 4223405 and Tk. 738165 respectively (Table-4). From the same table it appears that rate of return to variable cost and rate of return to total cost are respectively 200.99% and 127.92%, 162.68 and 91.69 and 128.06 and 62.69% for large, medium and small farm size groups during the year under study. It can therefore, be concluded that fish spawn production is definitely a profitable business for all farm categories in general and for large ones in particular.

Table 4. Different cost items and return per hatchery/farm

Item	Large		Medium		Small		All	
	Value (Tk.)	%	Value (Tk.)	%	Value (Tk.)	%	Value (Tk.)	%
Variable cost								
(a) Labor cost	235008	15.93	132804	17.88	81702	18.01	150142	16.76
(b) Total Material input cost	881955	59.79	410311	55.26	241970	53.33	515627	57.56
Total Variable cost	**1116963**	**75.72**	**543115**	**73.14**	**323672**	**71.34**	665770	74.32
Fixed cost								
(a) Tools and Equipments	111973	7.59	89579	12.06	55187	12.16	84680	9.45
(b) Farm building and structure	43083	2.92	34467	4.64	21234	4.68	32582	3.64
(c) Rental value of hatchery and pond area	203093	13.77	75400	10.15	53628	11.82	112840	12.60
Total fixed cost	**358149**	**24.28**	**199446**	**26.86**	**130049**	**28.66**	**230102**	**25.68**
Gross cost	**1475112**	**100**	**742561**	**100**	**453721**	**100**	**895871**	**100**
Return								
Spawn production (kg/farm)	2432		1022		530		1375	
Price of spawn (Tk./ Kg)	1362		1373.5		1367.5		1367	
Return from spawn (Tk./farm)	3312384		1403717		724775		1830781	
Return from brood sale	49665		19688		13390		28032	
Gross return	**3362049**		**1423405**		**738165**		**1858813**	
Operating profit to VC	2245086		880290		414493		1193043	
Net profit to total cost	**1886937**		**680844**		**284444**		**962942**	
Rate of return to VC (%)	200.99		162.08		128.06		179.20	
Rate of return TC (%)	127.92		91.69		62.69		107.49	

Cost and return per brood stock and per kg of brood stock

Cost and return per brood stock and per kg of brood stock are presented in Table 5. Analysis was done according to farm size groups in order to see the relative performance. Spawn production either per brood stock or kg of brood stock according to farm size groups shows no sharp variation among themselves. Small farmers however, achieved highest production both in terms of per brood stock and kg of brood stock. Total cost incurred per brood stock and kg of brood stock were respectively Tk. 324, 349 and 482 for large, medium and small farms and Tk. 123, Tk.151 and Tk. 219 for large , medium and small farms studied. It is so clear that relative performance of small farms were observed to be better than those of other two groups. Net profit to total cost per brood stock for large, medium and small farms were Tk. 414, Tk. 320 and Tk. 302 respectively while the same in relation to kg per brood stock were Tk. 188, Tk. 138 and Tk. 137 respectively. The rate of return to variable cost per brood stock as well as kg of brood stock according to farm size were found 201%, 162 and 128% respectively for large, medium and small hatchery farmers while the rate of return on total cost per brood stock as well as kg of brood stock have been estimated at 128 percent, 92 and 63% respectively for different hatchery farm categories during the study period (Table 5). So, the rate of return either to only variable cost or total cost seems to be fairly satisfactory and the farmers can invest more in hatchery industries.

Table 5. Cost and return per brood stock and per kg of brood stock

Item	Cost and returns per brood stock				Cost and returns per kg of brood stock			
	Large	Medium	Small	All	Large	Medium	Small	All
Production of spawn (kg)	0.53	0.48	0.56	0.53	0.20	0.21	0.26	0.21
Gross receipt (Tk.)	737.94	669.84	783.61	711.09	281.37	288.66	356.26	285.97
Total variable cost (Tk.)	245.16	255.58	343.60	254.69	93.48	110.14	156.21	102.43
Total fixed cost (Tk.)	78.61	93.86	138.06	88.03	29.97	40.45	62.76	35.40
Total cost (Tk.)	323.77	349.44	481.66	342.72	123.45	150.59	218.98	137.82
Operating profit to VC	492.78	414.25	440.01	256.41	187.89	178.52	200.04	183.54
Net profit to total cost	414.17	320.40	301.96	386.37	157.92	138.07	137.28	148.14
Rate of return to VC (%)	201.00	162.08	128.06	179.20	201.00	162.08	128.06	179.20
Rate of return to TC (%)	127.92	91.69	62.69	107.49	127.92	91.69	62.69	107.49

Conclusion

This paper analyzes the various management practices and profitability of fish hatchery operations in Bangladesh. This study showed that the proper management is the key element of any profitable business. Not only materials management but also different scientific/technical managements are involved in hatchery operations. Brood stock management is very important for fish hatchery. For maintaining good quality of brood, the operators have to take care on sources of brood, size, age and weight of brood, maintenance of male-female ratio, water quality and depth of pond. Improper maintenance of brood stock led to inbreeding of fish species which has resulted as inferior quality of seed. Spawning is most technical and scientific part of fish hatchery operations. The study also indicated that hormone pushed in brood at right time and right manner, selection of brood for spawning (that means size and age of the brood at spawning) are the critical determinants of obtaining good quality seed. A large amount of money is needed to build up overheat tank, jar, circular tank, DTW. The study proved that the hatchery operations in Bangladesh are lucrative. Gross return per farm was very satisfactory and the rate of return either to only variable cost or total cost seems to be fairly satisfactory. Based on the findings of this study, the hatchery business should be expanded more since this industry has good prospects in Bangladesh if they get technical and financial support from the government.

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