



Integrated farming of stinging catfish (*Heteropneustes fossilis*) and rabbit (*Oryctolagus cuniculus*) in farmer's pond

MD. ASHRAFULLAH, MITHUN KARMAKAR^{1*}, SHAYLA SULTANA MELY², MD. TARIQUL ISLAM AND MD. SHARIFUL ISLAM³

Department of Fisheries, Dhaka-134, Bangladesh

¹Quality Control Laboratory, Department of Fisheries, Dhaka-1000, Bangladesh

²Bangladesh Fisheries Research Institute, Mymensingh-2201, Bangladesh

³Bangladesh Fisheries Research Institute, Floodplain Sub-station, Shantahar, Bagura-5891, Bangladesh

*Corresponding author's E-mail: mithunkkbau14@gmail.com

Abstract. A study was carried out to evaluate the growth and production performances of stinging catfish (*Heteropneustes fossilis*) and rabbit (*Oryctolagus cuniculus*) under two treatments such as T₁ (shing-rabbit integrated system) and T₂ (shing monoculture) in farmers' pond. Twelve ponds from two villages such as Sutiakhali and Salakandi under Mymensingh sadar upazila were selected for the study. The average pond size was 5.5±0.23 decimal with a stocking density of 600 shing dec⁻¹. The ponds were only fertilized with rabbit dung except at the time of pond preparation at a rate of 1 kg dec⁻¹. Various environmental parameters such as temperature (°C), transparency (cm), PH, dissolve oxygen (mg L⁻¹), PO₄-P (mg L⁻¹), NO₃-N (mg L⁻¹), NO₂-N (mg L⁻¹), NH₃-N (mg L⁻¹), chlorophyll and alkalinity (mg L⁻¹) were monitored once in a week. The parameters were found to vary little from pond to pond and most of the parameters were within the suitable range for freshwater aquaculture in Bangladesh. The highest survival rate of fish was 95.36 ± 0.15 % in treatment T₁ and the lowest was 90.39 ± 0.10 % in treatment T₂. The survival rates of fish were not significantly different among the treatments ($P > 0.05$). The production of fish in T₁ and T₂ treatment was 25.36 and 20.43 kg dec⁻¹, respectively. Daily growth of shing in two treatments were 1.95 ± 0.01 and 1.88 ± 0.01 % respectively. The study revealed that integrated shing-rabbit would be highly profitable using improve extensive culture system in the rural household ponds through effectively reducing the use of pond fertilizer and fish feeding cost.

Keywords: Integrated aquaculture, Rabbit, *Heteropneustes fossilis*

Introduction

Livestock, fish, and crops can all be incorporated into a system where each component contributes to increase production and profit. Fertilizers are commonly used to enrich pond water productivity beyond natural condition and to provide additional organic matter for fish food (Kolo *et al.* 2003). Boyd (2018) stated that fertilization of the ponds with inorganic and organic matter is very important to increase fish yield, the expenses of which in fish culture are among the most significant production costs. In view of the insufficient resources the strategy should be to maximize production through optimum utilization of available resources within the limited base. Integrated farming system has a great role in production cost reduction (Islam *et al.* 2017). The promotion of integrated farming system is a developmental strategy that may help in alleviating the impending food crisis (Ansar and Fathurrahman 2018). It is a right way to develop freshwater fish culture and also a strategic measure of developing high valued food production technique. In integrated farming system nothing is wasted, the waste materials of one system become the valuable input for the other. They become mutually supportive if the wastes of one system become productive inputs for the other, and thus help in saving the external inputs.

Results of the present study may be helpful to the farmer in making right decisions regarding the selection of profitable farming system, which will ultimately help them to

allocate their scarce resources accordingly. It may also give some guidelines to the researchers and the policy makers towards for judicious planning for the agricultural development. Thus, the findings of this study may help the planners, policy makers, extension workers and those concerned with research on farmers' development programs. The specific objectives of this study were to evaluate the culture potential of integrated shing-rabbit farming; to determine the animal growth, survival and yield obtained from integrated farming system and to determine profitability of fish mono-culture and integrated shing-rabbit culture.

Materials and Methods

Study site and experimental design: Two villages like Sutiakhali and Salakandi were selected for the present study because rabbit farming is popular in those villages and almost all the households had fish pond.

The ponds were selected randomly to accommodate in the treatment. Six ponds were selected from each village and total twelve ponds from the two villages. Six ponds were used for shing monoculture (three in one village + three in other village) and six ponds were used for shing-rabbit integrated culture (three in one village + three in another village).

Collection of rabbit and management: Rabbits were collected from a rabbit farmer of Muktagacha area under Mymensingh district. In case of on station research, a rabbit shed ($5.0 \times 2.0 \times 2.0 \text{ m}^3$) was made on the pond dyke for keeping rabbits. The materials used for rabbit sheds were low cost and available in the rural areas viz. straw, bamboo etc. The green vegetables specially, Durva grass, German grass, leaves of pumpkin etc. were used as food for rabbit. Rabbits are very much sensitive to warm and cold weather. For this reason, during winter the rabbit-dwelling places were covered with straw, paper etc. In the same way, rabbit-dwelling places were provided with sufficient air and light during warmer season.

Pond preparation, fish stocking and management: Aquatic weeds, undesirable fish and other predatory animals were removed from the ponds manually. Liming was done in all the ponds at a rate of 1 kg/decimal. Three days after liming, the ponds were filled with water to a depth of 1.1 meter. The shing fingerlings were collected from a commercial fish seed hatchery named Mukti Hatchery Ltd., Shombugonj under Mymensingh Sadar upazilla, Mymensingh district. After transportation the fingerlings were stocked directly as the fingerlings were strong enough to withstand the stress during transportation. The ponds were stocked at a rate of 600 shing fingerlings/decimal. The stocking density in all the treatments was the same.

After stocking, only rabbit-dung was applied in pond as feed and fertilizer. No other manure was used. The rabbit-dung used to collect from the rabbit shed and applied every day in the pond. Before application the dung was weighted and kept overnight by adding water in an earthen pot locally called Chari.

Sampling of fish and water quality monitoring: Fingerlings were sampled at monthly intervals using bamboo hole and cast net. Length and weight of fish from each pond were measured separately to assess the health condition of fish and their growth.

Throughout the experimental period, the water quality parameters were recorded once in a week. Water temperature (°C), transparency (cm), pH, and dissolved oxygen (mg/L) were measured at the pond site. Temperature of water of pond was recorded in the field with the help of a Celsius thermometer. Transparency of water was measured by a Secchi disc of 40 cm in diameter. For determining dissolved oxygen (DO) of water, samples were collected from the ponds and were measured by a digital electronic oxygen meter (YSI, Model 58, USA). Hydrogen ion concentrations (pH) of water samples were determined at the pond site by using an electronic pH meter (Jenway, Model 3020, USA). Total ammonia was determined from collected water samples with the help of HACH Kit, (Model DR 2010, USA). The chemical reagent Rochelle salt and Nessler reagents were used as chemical reagents for total ammonia measurement.

Total alkalinity of the pond water sample was measured titrimetrically by using 0.02 N sulfuric acid and methyl orange as an indicator according to the standard procedure and method (APHA, 1992).

Phosphate-phosphorus of the pond water sample was determined at the Water Quality and Pond Dynamics Laboratory of the Fisheries Management Department, Bangladesh Agricultural University, Mymensingh by using a HACH Kit (DR-2010, USA) and necessary reagent pillow PhosVer-5.

Nitrate-nitrogen from the water samples was determined by using a HACH Kit (DR-2010, USA) and necessary reagent pillow Nitro Ver-5.

For determining the chlorophyll-a, 100 ml sample of water was collected and filtered through high quality glass microfiber filter paper (Whatman 4 F/C) by using a vacuum pressure air pump. Then the filter paper was preserved in 10 ml acetone in a test tube, ground with a glass rod and stored in a refrigerator for 24 hours. Later, a spectrophotometer (Milton Roy Spectronic, Model 1001) at 664 and 750 nm wave length was used to determine Chlorophyll *a* using the following formula (Boyd, 1979).

$$\text{Chlorophyll-a } (\mu\text{g/L}) = 11.9 (A_{664} - A_{750}) \frac{V}{L \times S} \times 1000$$

Where, A_{664} = the acetone at 664 nm; A_{750} = the acetone at 750 nm; V = the acetone extract in ml; L = the length of light path in the spectrophotometer in cm; S = the volume of ml filtered sample.

Determination of plankton population: For quantitative and qualitative study of phytoplankton and zooplankton of pond water, five liters of water sample was randomly collected from five different locations in each pond. Pond water was collected from surface and mid-depth and passed through a plankton net (mesh size 45µm) and finally concentrated to 50 ml. Then concentrated sample was poured into small, sealed plastic bottle and preserved in 10% formalin and then studied subsequently.

The plankton density was determined by using Sedge Wick-Rafter Counting cell (S-R cell) under binocular compound microscope (Swift, M-400). A 1-ml sub-sample of

each stored sample was transferred to the counting chamber of S-R cell. All planktonic cells/colony-forming units occurring in 10 fields of S-R cell selected at random were counted. The counting chamber is equally divided into 1000 fields, each containing of the volume of 0.001 ml.

Identification of plankton (phytoplankton and zooplankton) up to generic level was done according to Prescott (1962) and Bellinger (1992).

The calculation of plankton population was carried out by using the following equation:

$$N = \frac{A \times 1000 \times C}{V \times F \times L}$$

Where, N= Number of plankton cells of or units per liter of original water; A= Total number of planktons counted; C=Volume of final concentration of the sample in ml; V= Volume of field in cubic mm; F= Number of fields counted; L= Volume of original water in liter.

Analysis of data: All the collected data were recorded in Microsoft Excel 2007 and comparison of treatment mean was carried out using one-way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test. Significance at the 5% level ($p < 0.05$) using the SPSS (Statistical Package for Social Science) version-20.

Result and Discussion

Physico-Chemical parameters

Water quality parameters of the experimental ponds are presented in Table I. No definite pattern of variation in physico-chemical features of water was observed among the experimental ponds. Zhanget *al.*(1987) observed that pond size, depth, species density etc. affects the physico-chemical parameters of pond water. In this study, the ponds had similar size and shape and equal depth was maintained throughout the experimental period. This might be the cause of the physico-chemical properties of water to be remained in similar ranges in all the treatments. During the present study, the mean water temperature in treatment T₁ and T₂ was 30.38±1.55 and 30.44±1.29 °C respectively, which is comparable with the result of Aliet *al.*(1982) who observed similar fluctuation in temperature in freshwater fish ponds.

The mean values of water transparency of the pond under treatment T₁ and T₂ were 13.2±1.08 cm and 17.66±3.37 cm respectively. Azim *et al.* (1995), Hasan (1998) and Kohinoor *et al.*(1998) reported almost similar results in their study. Dissolved oxygen is one of the key factors for fish culture. The mean values of dissolved oxygen content recorded in the current study under treatment T₁ and T₂ was 3.12 ± 0.22 mg/L and 3.03 ± 0.32 mg/L respectively. Wahabet *al.*(1995) recorded dissolved oxygen ranging from 3.4 to 7.79 mg/L. The mean values of pH of the ponds were 7.01 ± 0.35 in treatment T₁ and 7.04 ± 0.05 in treatment T₂ respectively. The pH values of all the experimental ponds were about neutral, which indicates that all the ponds were productive. The present findings agreed with the findings of Dewanet *al.*(1991) and Nirod (1997) as recorded pH

ranges were 6.6 to 8.8. From the above discussion and previously published report on stinging catfish culture it may be concluded that all the temperature, dissolve oxygen and pH of the experimental ponds were within the suitable limits for stinging catfish culture (Mukul *et al.* 2023, Hossain *et al.* 2023, Saha *et al.* 2022).

Total alkalinity has little direct effect on the fish but indirectly the well-being of fish may be affected by total alkalinity, because water of low values of alkalinity are generally biologically less productive than those with high values (Lagler 1972). The minimum alkalinevalue of 120.61 mg/L was found in June and the maximum value was found to be 138.20 mg/L in October. Ahn *et al.*(2018) suggested a total hardness between 50 to 150 mg/L CaCO_3 is acceptable. The mean values of ammonia nitrogen were 0.18 ± 0.14 and 0.19 ± 0.10 mg/L in treatment T_1 and T_2 respectively. Wahab *et al.* (1995), Rahman (2000) and Kohinoor *et al.*(2000) found similar results.Total ammonia is toxic to fish and level above a certain threshold level can result in fish death. The acute lethal concentration of unionized ammonia-nitrogen for a fish species lies on the range of 0.2 to 2.0 mg/L (Alabaster and Liody 1982).In the present experiment, phosphorus ranged from 0.23 to 1.21 mg/L with a mean value of 0.62 ± 0.41 mg/L in treatment T_1 and 0.09 to 1.15 mg/L with mean value of 0.19 ± 0.28 mg/L in treatment T_2 . Similar results were found by Azim *et al.*(1995) and Nirod (1997). According to Alikunhi (1957) concentration of phosphate-phosphorus from 0.2 to 0.4 mg/L are within good productive range.The range of nitrate-nitrogen of the ponds as recorded in this study ranged from 0.1 to 1.10 mg/L. The amount of chlorophyll-ahas an important role on the productivity of water body. In the present study, the chlorophyll a ranged from 90.26 to 166.24 $\mu\text{g/L}$ which was more or less similar with the findings of Nirod (1997) who found chlorophyll-aranging from 32-627 $\mu\text{g/L}$.

Table I.Mean values ($\pm$ SD) with ranges of water quality parameters of experimental ponds under three treatments during the study period

Parameters	Treatment 1	Treatment 2	Level of significance
Temperature ($^{\circ}\text{C}$)	30.38 ± 1.55	30.44 ± 1.29	NS
Transparency (cm)	13.2 ± 1.08	17.66 ± 3.37	NS
Dissolved oxygen (mg L^{-1})	3.12 ± 0.22	3.03 ± 0.32	NS
pH	7.01 ± 0.35	7.04 ± 0.05	NS
Total alkalinity (mg L^{-1})	115.93 ± 5.88	123.6 ± 15.12	NS
Ammonia-nitrogen (mg L^{-1})	0.18 ± 0.14	0.19 ± 0.10	NS
Phosphate-phosphorus (mg/L)	0.62 ± 0.41	0.19 ± 0.28	NS
Nitrate-nitrogen (mg L^{-1})	0.01 ± 0.00	0.01 ± 0.00	NS
Chlorophyll a ($\mu\text{g L}^{-1}$)	157.92 ± 9.87	108.49 ± 45.90	NS

Plankton density

Plankton population in two treatments were enumerated and identified up to genus level. The results of the qualitative and quantitative studyof plankton population of the two treatments during the period of experiment have been presented in Table II and Table III. The abundance of total phytoplankton was $50.68 \pm 7.31 \times 10^3$ cells/L in treatment T_1 and

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47.17± 7.45 × 10³ cells/L in treatment T₂. Dewan *et al.* (1991) found similar phytoplankton abundance in the pond water. The mean values of zooplankton were 23.55 ± 4.92 ×10³ cells/L in treatment T₁ and 23.7 ± 6.32 ×10³ cells/L in treatment T₂. There were eleven genera of zooplankton representing Crustacea (4 genera) and Rotifera (4 genera) in the ponds water. Dewan *et al.*(1991) identified 7 genera of zooplankton comprising of Crustacea and Rotifera. Nirod (1997) and Rahman (2000) also found similar results.

Table II. Generic status of phytoplankton and zooplankton population in the treated ponds during the experimental period

Phytoplankton		Zooplankton
<i>Bacillariophyceae</i>	<i>Clostridium</i>	<i>Crustaceae</i>
<i>Navicula</i>	<i>Ceratium</i>	<i>Nauplius</i>
<i>Cyclotella</i>	<i>Gonotozygon</i>	<i>Daphnia</i>
<i>Melosira</i>	<i>Ankistrodesmus</i>	<i>Diaphnosoma</i>
<i>Chlorophyceae</i>	<i>Cyanophyceae</i>	<i>Moina</i>
<i>Chlorella</i>	<i>Anabaena</i>	<i>Rotifera</i>
<i>Spirogyra</i>	<i>Oscillatoria</i>	<i>Filinia</i>
<i>Pediastrum</i>	<i>Aphanocapsa</i>	<i>Trichocera</i>
<i>Volvox</i>	<i>Euglena</i>	***
<i>Closterium</i>	<i>Phacus</i>	***

Table III. Mean (±SD) plankton number of different groups under three treatments

Plankton group	Treatment 1	Treatment 2	Mean ± SD
Chlorophyceae	21.76 ± 1.62	21.14 ± 2.01	21.56 ± 1.6
Bacillariophyceae	16.11 ± 1.22	15.99 ± 1.46	16.40 ± 2.14
Cyanophyceae	8.63 ± 1.04	12.99 ± 1.46	12.40 ± 2.14
Euglenophyceae	4.09 ± 0.092	4.51 ± 1.26	4.25 ± 0.22
Total phytoplankton	50.68 ± 7.31	47.17 ± 7.45	48.44 ± 0.74
Rotifera	15.16 ± 1.82	16.32 ± 1.76	15.94 ± 0.68
Crustaceae	8.19 ± 1.18	7.38 ± 1.27	7.75 ± 0.40
Total zooplankton	23.55 ± 4.92	23.7 ± 6.32	23.36 ± 0.34

Growth and production of fish

Mean initial weight of 2.24±0.02 g and 2.22±0.02 g, mean weight gain of 42.02±0.16 g and 36.99±0.07 g and mean survival rate of shing was 95.36±0.15 and 90.39±0.10 % in treatment T₁ and T₂ respectively (Table 4). There was no significant difference in the survival rate of fish in two treatments. Similar types of survival rates were observed by Raihan (2001), who recorded the survival rates of 81 to 90% in a carp-SIS polyculture system in BAU ponds. The highest yield of shing was recorded 25.36 kg dec⁻¹153 days⁻¹ (6.26 mt/ha/yr.) in treatment T₁. Das *et al.* (1982) reported the production of 5,556

kg/ha/yr. fish at the stocking density of 7,000 fingerlings/ha in carp polyculture system. The production of the present study was almost similar to the above findings. The percent weight gains of shing in treatment T₁ and T₂ was 42.02±0.16 and 36.99±0.07 respectively. The highest % weight gain of shing was observed in treatment T₁. On the other hand, the lowest % weight gain observed in treatment T₂. The yield of fish in treatment T₁ is remarkably different ($p > 0.05$) from the treatment T₂. The best individual growth of shing was found in treatment T₁ followed by treatment T₂. The reason of this variation may be the lack of using rabbit-dung in treatment T₂. The growth and production performance of shing in terms of initial weight, final weight, weight gain, survival rate and total production are shown in Table IV. The trends in growth performance of shing in two treatments are shown in Fig. 1.

Table IV. Production of *Heteropneustes fossilis* in different treatments

Treatment	Stocking (Fish/decima l)	Initial weight (g)	Final weight (g)	Weight gain (g/fish)	SGR (%/Day)	Survival rate (%)	Production (kg/153days)
T1	600	2.24± 0.02	44.26± 1.17	42.02± 0.16	1.95± 0.01	95.36± 0.15	25.36 (6.26 mt/ha/y)
T2	600	2.22± 0.02	39.22± 1.42	36.99± 0.07	1.88± 0.01	90.39± 0.10	20.43 (5.05 mt/ha/y)

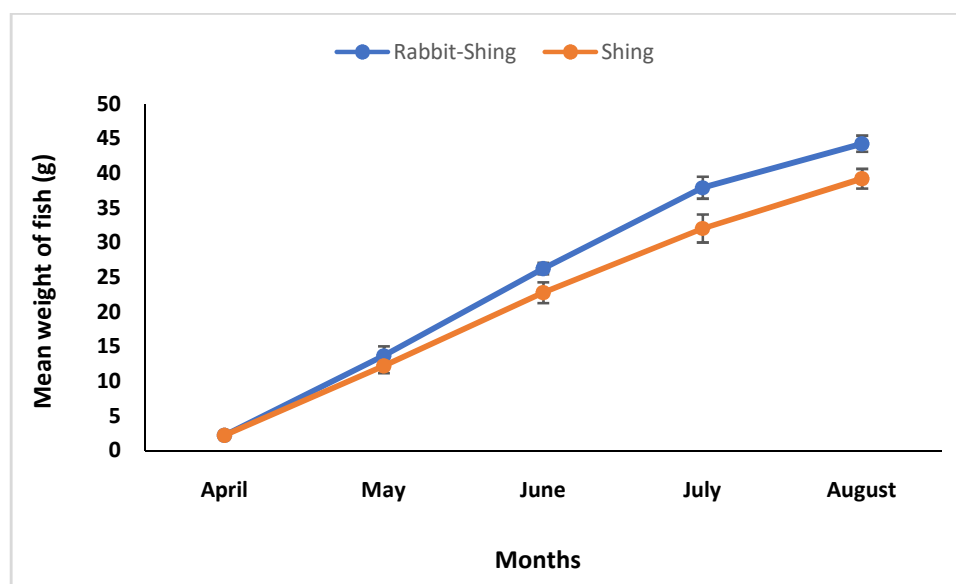


Fig .1. Monthly variations in growth performance of shing in different treatments.

The findings of the study revealed that, the highersurvival rate, growth, and production performances of stinging catfish was observed in shing-rabbit integrated culture system. This system can effectively reduce the pond fertilizer and fish feeding cost. Therefore,

shing-rabbit integrated farming can be recommended as a profitable fish culture technique in rural household ponds.

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