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## Carp-Based Small Indigenous Species (SIS) Fish Farming in Fattening Pond Under Barind Area in Rajshahi, Bangladesh

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### ABSTRACT

The present study was conducted on four experimental ponds (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>) each with three replications (R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>) in Tanore upazila (sub-district) of Rajshahi district, Bangladesh for a period of six months. Four treatments were assigned for this study as T<sub>1</sub> (silver carp-742/ha, catla-990/ha, rui-1485/ha, mrigel-990/ha and shing 5,000/ha), T<sub>2</sub> (silver carp-742/ha, catla-990/ha, rui-1485/ha, mrigel-990/ha and magur 5,000/ha), T<sub>3</sub> (silver carp-742/ha, catla-990/ha, rui-1485/ha, mrigel-990/ha and pabda 5,000/ha) and T<sub>4</sub> (silver carp-742/ha, catla-1235/ha, rui-1729/ha and mrigel-1235/ha) each with three replications. The initial average weight of fish was silver carp (*H. molitrix*)-252.53g, catla (*G. catla*) - 270g, rui (*L. rohita*)-245g, mrigel (*C. mrigala*)-235g, shing (*H. fossilis*)-2.03g, magur (*C. batrachus*) -3.28g, pabda (*O. pabda*)- 1.51g respectively. Supplementary feeds were applied at an average rate of 5% of the body weight of fish. During the study period, it was found that the water quality parameters were within the acceptable ranges for carp-based small indigenous species fish farming in the study area. In case of growth performances, Treatment T<sub>2</sub> showed the highest Yield followed by T<sub>1</sub>, T<sub>3</sub> and T<sub>4</sub>.

### INTRODUCTION

Bangladesh is an agro-based country and is striving hard for rapid development of its economy. It is often argued that the future development of the country depends particularly on the agricultural sectors, especially fisheries. Fisheries are one of the major components of agricultural activities in Bangladesh and plays a vital role in nutrition, employment, income generation, and foreign exchange earnings (Mazid M. A. 2002). About 19 million people, more than 12 % of the total population are employed (full time and part-time) in fisheries sector to earn their livelihood involving activities related to fisheries (DoF, 2021). So, fish and fisheries are an indispensable part in the life and livelihoods of the people of Bangladesh and it is also the part of our cultural heritage.

Most of the people in our country depend on fish as the main source of protein. Fish, which is rich in high-quality protein, lipid and minerals, is nutritionally better to meat. Bangladesh has got a large number of ponds scattered all over the country. There are 47,04,195 ha water bodies of which 4,07,625 ha ponds are suitable for fish culture. So, the country has good potential for freshwater aquaculture, this potential cannot be fully utilized for various reasons (DoF, 2021). Fish resources play a very important role in the economy of Bangladesh accounting for about 3.57% of GDP. About 1.24% of annual export earnings comes from the fisheries sector and it ranks 3rd among the export-oriented industries (DoF, 2021).

Malnutrition is a serious problem that is caused mainly due to animal protein deficit diet. Like other countries of the third world, Bangladesh today is facing the severe

and widespread protein and calorie malnutrition problem resulting from low per capita consumption of protein on the one hand and low intake of food on the other hand. Per capita annual fish needed is 21.90 kg, whereas the per capita annual fish intake 23 kg.

Among different technologies of fish culture, polyculture is one of the most acceptable cultural techniques. From the historical facts, this system was started in China (Ling, 1987; Chang, 1987). The outcome of fish production from polyculture systems depends on the species combinations and their stocking densities. Dominating species for pond aquaculture are Indian major carp and exotic carp. Polyculture or composite culture is the system in growing fast-growing compatible species of different feeding habits are stocked in different proportions in the same pond. (Jhingran, 1975). The basic principle of the polyculture ideas that when compatible species of different feeding habits with cultured in the same pond, the maximum utilization of all requirements. It is a fact that polyculture may produce an expected production of fish with different feeding habits if stocked in proper ratios, densities and combinations (Halver, 1984).

Carp polyculture is the most popular form of aquaculture practice in Rajshahi and Natore districts. Though there are at least 260 freshwater fish species in the country but only 4 native and 12 exotic carp species are cultured in Bangladesh (DoF, 2021). Some non-carp species are also brought under culture lately in the country. However, the Potentiality of carp polyculture is beyond to the reach to be sustainable due to climate change which makes the fisheries sector in Bangladesh vulnerable to environmental

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degradation in various Magnitudes, such as groundwater sinking and contamination through pollutants (DoF, 2021). This phenomenon is mostly true for the northwest part of Bangladesh which is a typical barind tract region characterized by red or yellow clay soil, limited rainfall and lack of water resources in the dry season. This consequence, poor survival and reduced growth of cultured fish species are evident frequently in drought-prone barind area (Hossain, 2011). The appropriate technique is felt necessary to increase fish production in vulnerable barind area due to climate change.

Fattening is a popular technique to increase biomass in animal rearing and this practice is often followed for the production of beef cattle (Sarma et.al. 2014) and crab (Ferdousi 2013) in Bangladesh. Carp fattening is a new technology in Bangladesh where overwintered and large-size fishes are stocked to gain higher biomass within shorter period. Larger stocking density under lower density can help to obtain maximum fish biomass within a shorter period of time (Grover et.al. 2000). However, appropriate this technology is considered potential for Barind (Rajshahi, Naogaon) area where culture period is shorter than other zones. So, the number of the fattening pond are found to be increased day by day. Small indigenous species (SIS) of fish are important to the rural poor in many countries of Asia as they are relatively cheap, are consumed whole and have higher nutritive value than many cultured species (Thilsted

1997). Small indigenous species have several additional advantages, including self-recruitment, growing fast-growing, feeding at low trophic levels and having a high content of micronutrients, including calcium and vitamin A (Thilsted, Ross & Hassan 1997)

Now a days carps and SIS polyculture is not a new thought in Bangladesh but there is no available information on culture of carps and SIS especially Shing, Magur, Pabda in carp fattening pond in a polyculture system. Several research efforts are taken on carp polyculture in pond but there is no information on Carp based SIS (small indigenous species) fish farming in the fattening pond. Hence, the present research works has been designated and proposed to polyculture technique of Carps i.e. rui (*L. rohita*), catla (*G. catla*), mrigel (*C. mrigala*), silver carp (*H. molitrix*) with small indigenous species i.e. shing (*H. fossilis*), magur (*C. batrachus*), pabda (*O. pabda*) in fattening pond to assess the water quality parameters of experimental ponds and fish growth and to recommend suitable SIS fish for carp-SIS polyculture in ponds.

## MATERIALS & METHODS

### Location and Duration of the Study Area

The present study was conducted in Tanore upazila under Rajshahi District for a period of six month from July 2019 to December 2019. (Fig.01). 12 experimental ponds with an average area of 0.78 ha and average depth of 3m were selected for this study.



**Figure 1:** Location of study area indicated with blue marks (●) at Tanore upazila of Rajshahi district, Bangladesh.

### Experimental Design

The experiment consisted of four treatments with three replications. Four treatments were assigned for this study as  $T_1$  (silver carp-742 ha-1, catla-990 ha-1, rui-1485 ha-1, mrigel-990 ha-1 and shing 5,000 ha-1),  $T_2$  (silver carp-742 ha-1, catla-990 ha-1, rui-1485 ha-1, mrigel-990 ha-1 and magur 5,000 ha-1),  $T_3$ -(silver carp-742 ha-1, catla-990 ha-

1, rui-1485 ha-1, mrigel-990 ha-1 and pabda 5,000 ha-1) and  $T_4$ -(silver carp-742 ha-1, catla-1235 ha-1, rui-1729 ha-1 and mrigel-1235 ha-1) each with three replications. The initial average weight of fishes were silver carp-252.53g, catla- 270g, rui-245g, mrigel-235g, shing-2.03g, magur-3.28g, pabda- 1.51g, respectively (Table 1).

**Table 1:** Layout of the experimental system

Treatment	Replication	Average pond area (ha)	Species combination	Stocking density (ind./dec)
T <sub>1</sub> (carps+ shing)	R1	0.80	<i>H. molitrix</i>	3
	R2		<i>C.catla</i>	4
	R3		<i>L.robita</i>	6
			<i>C.mrigala</i>	4
			<i>H.fossilis</i>	20
T <sub>2</sub> (carps+ magur)	R1	0.73	<i>H. molitrix</i>	3
	R2		<i>C.catla</i>	4
	R3		<i>L.robita</i>	6
			<i>C.mrigala</i>	4
			<i>C.batrachus</i>	20
T <sub>3</sub> (carps+ pabda)	R1	0.53	<i>H. molitrix</i>	3
	R2		<i>C.catla</i>	4
	R3		<i>L.robita</i>	6
			<i>C.mrigala</i>	4
			<i>C.batrachus</i>	20
T <sub>4</sub> (Only carps)	R1	1.06	<i>H. molitrix</i>	3
	R2		<i>C.catla</i>	5
	R3		<i>L.robita</i>	7
			<i>C.mrigala</i>	5

**Pond Management**

Experimental ponds were subjected to lime at the dose of 250kg/ha after removal of aquatic weeds and unwanted species to neutralized soil, kill pathogenic bacteria and promote biological productivity. Fertilization was done after five days of liming. Ponds were fertilized with Urea-50kg/ha and TSP 50kg/ha before stocking of fish. Carp seeds were subjected to overwintering process whereas seeds of SIS fishes were shifted from nursery rearing to farmer managed grow out pond for stocking. SIS were fed floating pelleted feed containing 35% protein at the rate of 6% of the body weight (10% at first, 8% at second, 6% at third and fourth, 5% at fifth and sixth and 4% at rest of the fortnights). Twice daily feeding (morning and evening) was followed for all the treatments. Feed ration was adjusted through fortnightly sampling.

**Monitoring of Water Quality Parameters**

Water quality parameters of the experimental ponds were monitored between 09:00 and 10:00 am. Temperature was recorded with the help of a Celsius thermometer at 20–30 cm below the water surface. Water transparency (cm) was measured by a Secchi disk. Dissolved oxygen (mg L<sup>-1</sup>), pH and total dissolved solids (TDS, mg L<sup>-1</sup>) were determined by a Multimeter (HQ 40D, HACH, USA). Alkalinity (mg L<sup>-1</sup>) and ammonia-nitrogen (mg L<sup>-1</sup>) were determined by the help of a HACH kit (FF2, USA).

**Determination of Fish Growth and Yield**

Growth (in terms of initial weight; final weight; weight gain and survival rate) and yield of fishes were determined after Brett and Groves (1979) as follows:

Initial weight = Weight of fish at stock

Final weight = Weight of fish at harvest

Weight gain = Mean final weight – Mean initial weight

Survival rate (%) = No. of fish harvested /No. of fish stocked × 100

Yield/production (kg/ha/yr) = No. of fish harvested × Final weight of fish.

**Statistical Analysis**

Water quality parameters; fish growth and yield; and economics of SIS-carp polyculture under different treatments were analyzed by one-way analysis of variance (ANOVA). When a mean effect was significant, the ANOVA was followed by Duncan Multiple Range Test (Duncan 1955) at 5% level of significance (Gomez and Gomez 1984). The percentages and ratio data were analyzed using arcsine transformed data. All analyses were performed using SPSS (Statistical Package for Social Science) version 20.0 (IBM Corporation, Armonk, NY, USA)

**RESULT AND DISCUSSION**

**Water Quality Parameters**

The mean values of water quality parameters under different treatments are presented in Table 2. During the study period, variations in species had no significant effect (p > 0.05) on temperature, transparency, pH and NH<sub>3</sub>-N of the pond water and all the parameters were within the suitable limit for SIS-carp farming (Alikunhi 1957; Boyd 1998). However, treatments showed a significant variation (p < 0.05) in DO and alkalinity concentration of water in ponds due to species variation.

**Table 2:** Water quality parameters in different treatments of SIS-carp farming

Parameters	Treatments				F value	P value
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>		
Temperature (°C)	31.03±0.45a	30.61±0.68a	30.80±0.91a	30.56±1.05a	2.17	0.169
Transparency(cm)	28.23±4.79a	25.53±3.51a	26.40±3.34a	25.93±1.59a	0.348	0.792
pH	7.34±0.41a	8.25±0.49a	7.52±0.54a	7.56±0.60a	1.77	0.229
DO (mg L <sup>-1</sup> )	5.65±0.35a	5.45±0.40ab	5.26±0.44ab	4.92±0.17b	2.20	0.01
NH3-N (mg L <sup>-1</sup> )	0.0833±.035a	0.0113±.006a	0.0767±0.02a	0.12±0.07a	0.58	0.641
Alkalinity (mg L <sup>-1</sup> )	158.63±10.10a	152.15±15.93a	122.56±11.32b	140.69±18.49b	7.01	0.002

NS. Non-Significant; \* P<0.05

There was no noticeable effect of environmental parameters on productivity of fish species. Mondal *et al.* (2018) recorded temperature range of 27.53 to 29.38°C, alkalinity ranging from 87.85 to 102.61 mg L<sup>-1</sup> and pH value from 7.70 to 8.06 in carp-SIS polyculture ponds. Hossain *et al.* (2018) recorded temperature range of 31.49 to 31.74°C, DO range of 5.93 to 6.32 mg L<sup>-1</sup> and pH range of 7.12 to 7.93 mg L<sup>-1</sup> in polyculture of stinging catfish (*H. fossilis*) with Indian major carps in ponds. The transparency of productive water bodies should be 40 cm or less according to Rahman (1992). Ali *et al.* (2018), in their study on *H. fossilis*, *Oreochromis niloticus* and *Barbonymus gonionotus* culture in ponds, recorded temperature between 30.33 and 31.42°C, DO between 5.61 and 6.03 mg L<sup>-1</sup>, transparency between 28.67 and 46.33 cm and total alkalinity between 129.17 and 151.83 mg L<sup>-1</sup>. However, TDS of 268.44 to 280.02 mg L<sup>-1</sup> was reported in homestead pond (Nabi *et al.* 2020) which is comparatively lower than the present study. This variation in TDS might be due to the variation in soil-water quality. This assumption is all most agreed with Hossain (2011) while working on water quality and fish growth in red soil area of Bangladesh. However, the TDS values recorded in this study seem to be within suitable range for fish culture as fish do not appear to be affected by standard

concentrations of 2000 mg L<sup>-1</sup> (Rana and Jain 2017)

### Fish Growth and Yield

Variations among the treatments in growth performances were recorded across treatment groups (Table 3). Despite no variation in growth of most of carps species overall production varied significantly across treatments (p < 0.05) which is due to growth performances of SIS fishes. The growth performance of *C. batrachus* in T<sub>2</sub> was better than *H. fossilis* in T<sub>1</sub> and *M. cavasius* in T<sub>3</sub>. Dietary protein content is also considered an important factor for biomass increase within shorter period in ponds with higher density stocking of catfishes. Mean weight gain (87.92 ± 1.56 g 4-month<sup>-1</sup>) of *C. batrachus* was recorded in this study and this was found comparatively better than the weight gain (41.14 ± 0.15 – 56.10 ± 0.86 g 6-month<sup>-1</sup>) recorded by Reza *et al.* (2021) using 28% protein containing diet. Hussain *et al.* (2008) recommended 30 – 35% protein content in diet for farming of *C. batrachus* in ponds. However, higher protein content in feeds has also been used for *Clarias gariepinus* farming in earthen ponds (e.g. 43%, Oke *et al.* 2016). The current findings also agreed with Ali *et al.* (2018) and Rasowo *et al.* (2008) who recommended 35% protein content in diet for farming of *Clarias* spp.

**Table 3:** Growth performance and Production of Carps and SIS species under Four different treatments over a culture period

Parameters	Species	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
Initial mean Wt.(g)	<i>H. molitrix</i>	257.58±12.84a	249.34±12.64a	262.62±9.67a	240.61±8.56a
	<i>G.catla</i>	276.82±24.99a	259.91±17.03a	276.54±29.24a	268.89±24.86a
	<i>L.robita</i>	249.33±4.40a	242.24±10.44a	250.53±18.79a	243.67±6.22a
	<i>C.mrigala</i>	237.93±2.90a	235.13±6.52a	235.72±3.76a	235.35±5.62a
	<i>H.fossilis</i>	2.03±.07a	-	-	-
	<i>C.batrachus</i>	-	3.28±.20a	-	-
	<i>O. pabda</i>	-	-	1.51±.06a	-
Final mean wt.(g)	<i>H. molitrix</i>	1769.68±10.24a	1674.05±13.43b	1667.99±18.98b	1685.83±53.47b
	<i>G.catla</i>	1869.31±41.97a	1836.88±13.59a	1825.98±17.50a	1908.85±90.81b
	<i>L.robita</i>	1682.78±28.38a	1626.64±16.92a	1635.48±51.11a	1690.74±42.50a
	<i>C.mrigala</i>	1525.39±80.74a	1495.67±6.13b	1452.30±6.91b	1586.48±41.16a
	<i>H.fossilis</i>	209.96±12.89a	-	-	-
	<i>C.batrachus</i>	-	327.83±14.66a	-	-
	<i>O. pabda</i>	-	-	166.04±12.64a	-

Weight gain (g)	<i>H. molitrix</i>	1512.10±10.24a	1424.71±13.43b	1412.37±18.98b	1445.22±53.47b
	<i>G.catla</i>	1592.86±41.97a	1576.97±13.59a	1549.44±17.50a	1639.96±90.81b
	<i>L.robita</i>	1433.45±28.38a	1384.40±16.92a	1348.95±51.11a	1447.07±42.50a
	<i>C.mrigala</i>	1433.45±80.74a	1260.54±6.13b	1216.58±6.91b	1351.13±41.16a
	<i>H.fossilis</i>	207.93±12.89a	-	-	-
	<i>C.batrachus</i>	-	324.55±14.66a	-	-
	<i>O. pabda</i>	-	-	164.53±12.64a	-
Yield (kg/ha/6 months)	<i>H. molitrix</i>	796.35±5.64a	726.95±11.75b	736.43±9.91b	805.32±6.56a
	<i>G.catla</i>	1635.64±13.25b	1630.54±11.14a	1636.49±6.03a	1735.97±4.49b
	<i>L.robita</i>	1937.30±6.64a	1860.60±6.94ab	1842.29±7.43a	2032.07±5.15b
	<i>C.mrigala</i>	1340.43±2.19a	1307.17±5.68b	1318.03±11.55a	1436.81±6.76ab
	<i>H.fossilis</i>	1026.17±3.51a	-	-	-
	<i>C.batrachus</i>	-	1607.71±5.97a	-	-
	<i>O. pabda</i>	-	-	1159.14±4.44a	-

Figures bearing common letter(s) in a column as superscript do not differ significantly ( $p > 0.05$ )

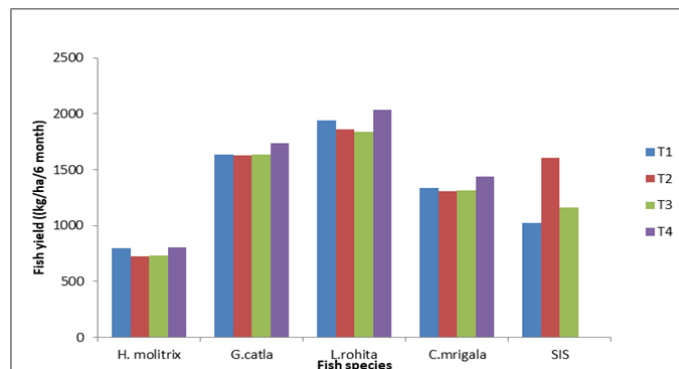
Variations in fish yield under the treatments are shown in Table 4 and Figure 2. Fish yield in  $T_2$  was 18.78% and 73.27% higher than  $T_1$  and  $T_3$ , respectively. This study almost agreed with Samad and Imteazzaman (2019) who worked on the monoculture of *C. batrachus* in ponds and recorded survival rate as 92% and yield as  $1498.2 \pm 345.2$  kg ha<sup>-1</sup> 3-month<sup>-1</sup>. The overall fish yield recorded in  $T_2$  was also closer to the yield ( $6610.27$  Kg ha<sup>-1</sup> 6-month<sup>-1</sup>) recorded by Hossain *et al.* (2018) in polyculture of *H. fossilis* with Indian major carps in ponds. However, comparatively higher growth and yield performance

in  $T_2$  might be due to the effect of individual size and metabolism. Although there was no significant difference in initial stocking weight of catfishes across treatments, but comparatively highest weight gain was recorded for *C. batrachus* followed by *H. fossilis* and *M. cavasius*. In adult condition, the highest length recorded as 45.7 cm in *C. batrachus* and 30 cm each for *H. fossilis* and *M. cavasius* (DoF 2018). Actually, the fish with lower body size results higher metabolic activity and thus produces lower biomass (Boyd 1998).

**Table 4:** Fish yield ((kg/ha/6 month) in different treatments

Species	Weight (g)				F value	P value
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>		
<i>H. molitrix</i>	796.35±5.64a	726.95±11.75b	736.43±9.91b	805.32±6.56a	72.15	0.01
<i>G. catla</i>	1635.64±13.25b	1630.54±11.14a	1636.49±6.03a	1735.97±4.49b	103.43	0.02
<i>L. robita</i>	1937.30±6.64a	1860.60±6.94ab	1842.29±7.43a	2032.07±5.15b	13.49	0.02
<i>C. mrigala</i>	1340.43±2.19a	1307.17±5.68b	1318.03±11.55a	1436.81±6.76ab	5.91	0.04
<i>H. fossilis</i>	1026.17±3.51a	-	-	-	32.68	0.00
<i>C. batrachus</i>	-	1607.71±5.97a	-	-	64.89	0.00
<i>O. pabda</i>	-	-	1159.14±4.44a	-	51.95	0.00

Values in the same row having different superscript letters are significantly different ( $p < 0.05$ )



**Figure 2:** Variation in yield in different treatments of SIS-carp farming

## CONCLUSION

Now-a-days carp fattening is growing as an improved technology in carp polyculture where higher biomass can be obtained at a shorter period of time. But in this technology total cost-benefit ratio is very low, to improve CBR rate farmers should add small indigenous fish (specially *C. batrachus*) in the fattening pond to improve their income, as well as the producers put forward some suggestions prominent of which were an easy procedure for obtaining a bank loan, availability of fish seed and inputs at the proper time, training, improved marketing facilities, low rate of interest and implementation of Govt. rule. Overall findings indicated that Carp fattening only be highly profitable when there would include highly valued small indigenous fish species. It also indicated that among small indigenous species, *C. batrachus* (treatment 2) would have the most suitable species for carp-based small indigenous species fish farming in the fattening pond.

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