

Integration of High Priced Small Indigenous Fish with Conventional Carp Culture for Nutritional Security and Rural Livelihood

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Abstract – A polyculture experiment involving Indian Major Carps - rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*); exotic carps- silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio*); and self recruiting small indigenous fish mola (*Amblypharyngodon mola*), punti (*Puntius sophore*) and chela (*Salmmostoma bacaila*) was carried out in the earthen ponds of 100 m² at 24 South Parganas, West Bengal, India. The main objective was to study net flesh biomass production from unit area of pond by incorporating small indigenous fish of regional demand and enhance economic return per unit area of pond with diversified culture of small indigenous fish. Fifteen ponds, each of size 100 m², were prepared as per the standard management practice followed for composite fish culture. Four treatments in triplicate were tested. T-1 was with carps and mola, T-2 was with carps and puntius and T-3 was with carps and chela. Carp seeds (rohu, catla, mrigal, silver carp, grass carp, common carp) were stocked @10,000 no. per ha while small indigenous fish species viz. *A. mola*, *P. sophore* and *S. bacaila* were collected from wild and reared separately before introducing into the carp culture ponds @ 20,000 no. per ha. Treatment (T-4) was used as control. In T-4 conventional carp species were reared. Experimental trials were conducted for six months. At the end of the experiment, the net benefit calculated per ha area turned out to be Rs. 1,393 565.50, 1,03043, 58,740.50 and 1, 07185 in the treatments 1, 2, 3 and 4 respectively.

It was observed that though production per ha in T- 4 was maximum (2031.43 kg) but net profit was maximum in T- 1 which contained carps and the small indigenous fish, mola. The experiment clearly indicates that integration of high priced small indigenous fish to the conventional carp culture is a viable proposition as it provides additional income without effecting production of carps and the model will provide additional source of income to small-scale farmers. Specifically, integration of mola in polyculture of carps may be a better option as it has ensured higher production of nutritionally rich mola and also from economic point of view this system is encouraging for rural people because they would get mola regularly for consumption and carps as cash crop.

Keywords – Small Indigenous Fish, Polyculture, Mola, Puntius, Chela, Nutritional Security, Rural Livelihood.

I. INTRODUCTION

India is a basically carp producing country which includes both indigenous (catla, rohu, mrigal) and exotic carps (silver carp, grass carp and common carp). They account for bulk of the production, being as much as 87%

of the total aquaculture production. Indian fisheries research has mainly concentrated on aquaculture of carps. In the process, valuable local fish species which were and are relished by local people of particular region did not get much attention. However, the fact remains that these small fish species fetch more value than the carp, indicating an ardent need of focused research efforts towards the development and conservation of these fishes before they become extinct. Recent research has highlighted the importance of self-recruiting species (SRS) in both natural and managed habitats to the livelihoods of the rural poor (Roos et al. 1999, Mazumdar and Lorenzen 1999). A range of indigenous and introduced fish species are inevitably present in many rural aquaculture systems of India unless deliberately eradicated. Extensive aquaculture involving the small indigenous species in aquaculture is a source of additional income and additional nutrition to the rural families, incurring no additional cost and is environment friendly. Among traditional communities, indigenous knowledge about the health benefits of such species exists. For example, mola (*A. mola*), commonly found in east and northeast India, is often included in the diet of pregnant and lactating mothers, for its recuperative value. The role of SIF in providing micronutrients is very critical especially where micronutrient deficiency is a big problem (Thilsted et al. 1997, Zafari and Ahmed 1981). Therefore, diversification of aquaculture with high valued small fish species of regional importance holds great promises. In this context, the present study was conducted with a view to assess the net flesh biomass production from unit area of pond by incorporating three small indigenous fish of local preference.

II. MATERIALS AND METHODS

The experiment was conducted from June to December 2010 in fifteen earthen ponds of 100 m² each with a depth of 1.5 m at South 24 Parganas, West Bengal, India at Latitude: 21.89 N, Longitude: 88.19 E.

A. Experimental Design

Experimental trials of five treatments were conducted in triplicate. Treatment -1 (T-1) was of carps with mola, Treatment-2 (T-2) was of carps with puntius, Treatment-3 (T-3) was of carps with chela, while treatment-4 (T-4) consists of only carps and Treatment-5 (T-5) consists of combination of only small indigenous fish. Ponds were primarily rain fed. They were dried out and embankments

of all the ponds were repaired. The lime was applied @ 350 kg ha⁻¹ (50% in 1st installment and rest in equal split doses at monthly interval) and fertilized with raw cattle dung @ 5000 kg ha⁻¹ (monthly dose @500 kg ha⁻¹). Thereafter, the ponds were filled-up with water from deep tube well. The management details and input cost of production for each pond is presented in Table-1.

Carp seeds (rohu, catla, mrigal, silver carp, grass carp, common carp) having average weight 10.00±6.00 g were stocked @10,000 no. per ha in the month of July 2010 in all the ponds, except T-5. The stocking of brood fish of SIS (avg. wt 1.00±0.50 g) was done during August 2010 @ 2 no. per square meter. Small indigenous species viz. *A. mola*, *P. sophore* and *S. bacaila* were stocked in T- 1, T-2 and T-3 respectively. In T-5, combination of mola, punti and chela (each 500 nos.) were stocked. Agricultural bi-products, such as rice-bran and mustard oilcake (mixed together in a ratio of 1:1), were used as supplementary feed at the rate of 2% of the body weight, once a day.

B. Water Sample Collection and Water Analysis

Water quality parameters were recorded between 8.30 and 9.30 am at monthly interval. The water quality parameters such as Temperature (°C), Transparency (mg), pH, DO (mg/l) and Hardness were determined following standard methods.

C. Fish Sample Collection

Specimens were randomly undertaken for further investigation at monthly interval from each pond. Morphometric study was done of individual fishes. Length, weight, survival and behavior of the fish were observed. Healths of the fish were also monitored.

D. Harvesting

Partial harvesting of small fish in all the treatments was done after two months of stocking. All ponds were completely harvested after six months of rearing, first by drag netting and then by draining out of the ponds. During harvesting, all the fishes were counted and weighed individually for each pond to assess the survival and production. The overall economics of different treatments were calculated on the basis of the expenditure incurred and the total return from the selling price of fish. The cost of lime, cattle dung, fertilizer and fish seed (including transport) and rice bran, oil cake was estimated. At the end of the experiment, fishes were sold in a local market and the return was estimated.

weight of 205.30 g in treatment-1, 194.00 g in treatment-2, 56.60 g in treatment-3 and 434.60 g in treatment-4. Higher growth rate was recorded in treatment-4 followed by treatment-1. The average weight attained by rohu was recorded to be 178.60, 193.30, 197.30 and 216.60 g in treatment-1, 2, 3 and 4 respectively. The highest growth was recorded in treatment-4. The average weight of silver carp at the time of harvesting was observed as 240.00, 424.00, 230.60 and 400.60 g in treatment-1, 2, 3 and 4 respectively. The average weight of grass carp at the time of harvesting was observed as 105.00, 84.60, 71.33 and 105.30 g in treatment-1, 2, 3 and 4 respectively. The average weight of common carp at the time of harvesting was observed as 176.30, 104.00, 133.30 and 123.00 g in treatments, T-1, T-2, T-3 and T-4 respectively.

The final average weight of mola, punti and chela in treatment T-1, T-2 and T-3 was 2.66±2.01, 4.05±1.98 and 1.32±1.08 g. In all the treatments, the average final weight of experimental small indigenous fish was less than initial weight because the fishes were bred and number of fish has increased with smaller individuals.

The survival rate of various species in different treatments was fairly high. The maximum survival was of silver carp (98%), mrigal (95.3%), silver carp and common carp (100%) and silver carp (90%) in treatment 1, 2, 3 and 4 respectively.

After six months culture period, the productions obtained were 1897.18, 1953.54, 1526.8 and 2031.43 kg/ha from the treatments T-1, T-2, T-3 and T-4 respectively. The highest production was obtained from T-4 where only carps were stocked, followed by T-2 (carp with punti) and T-1 (carp with mola). The lowest production of 1526.8 kg ha⁻¹ was obtained with treatment-3, where carps were stocked with chela. In T-1 where mola was stocked, the production was less than T-2 and 4 but mola contributed 16.09 % to the total production. Punti contributed 3.7% while chela contributed only 2.64% in total production in the treatments 2 and 3 respectively.

The total revenue per ha was calculated as Rs. 2,35,520.50, 1,98,998.00, 1,54,695.50 and 2,03,140.00 from treatments T-1, T-2, T-3 and T-4 respectively. The total operational cost was Rs. 95,955.00 per one ha. The net benefit calculated per ha area turned out to be Rs. 1, 39565.50, 1,03043, 58,740.50 and 1, 07185 in the treatments T-1, T-2, T-3 and T-4 respectively.

III. RESULT

The mean values of water quality parameters of different experimental ponds are presented in Table-2 along with statistical treatment of data. Details of stocking, harvesting, survival and production of fish species are presented in Table-3. On the basis of final growth attained by each species, it was observed that among all the species, the highest average weight was attained by Mrigal in Treatment-1 (278 g) while in Treatment-2, 3 and 4, it was silver carp (424.00, 230.60 and 400.00 g respectively). When compared, the final average weight of silver carp was significantly high (P<0.05) in treatment-4 than that of other treatments. Catla reached an average

Table 1. Management details and input cost of production in each pond (size= 0.1ha)

Sl. No.	Activity	Input used	Quantity used (kg)	Input price Rs/per kg	Total (Rs.)
1	Weed clearance (manually)	-	-	-	200
2	Manuring (Basal dose)	Raw cow dung @ 5000 kg/ha/yr	500	0.5	250
3	Liming (Basal dose)	Lime (50%) @ 350 kg/ha/yr	17.5	7.5	131.25
4	Stocking of fish seed	Carp	25	100	2500

5	Manuring (Monthly dose)	Raw cow dung @ 500 kg/ha/yr	350	0.5	175
6	Liming (Monthly dose)	Lime (50%) @ 350 kg/ha/yr	17.5	7.5	131.25
7	Feeding	Rice bran	196	7	1372
		MOC	196	16	3136
8	Netting charges	-	-	-	1200
9	Dewatering of pond	-	-	-	500
Total					9595.50

	SC	200	230.66	46.132			
	GC	100	71.33	4.993			
	CC	150	133.33	19.999			
	SB	2000	1.32±1.08	4.031			
Total					152.68		
T-4	C	200	434.66	55.636	203.14	2031.4	(@Rs.100/- per kg) 203143.00
	R	200	216.66	30.549	43	3	
	M	150	290.66	36.623			
	SC	200	400.66	72.118			
	GC	100	105.33	6.003			
	CC	150	123.00	2.214	203.143		

C-Catla, R-Rohu, M-Mrigal, SC-Silver Carp, GC-Grass Carp, CC-Common Carp AM-Mola, PS-Punti, SB-Chela

Table 2. Mean values (\pm SE) of water quality parameters along with statistical relationship in different treatments

Parameters	T-1	T-2	T-3	T-4	F value
Water temp (°C)	28.56±0.22	28.60±0.21	28.54±0.20	28.46±0.24	0.055*
Transparency (cm)	32.0±0.85	29.26±0.72	27.74±0.88	36.70±1.06	18.57 ^{NS}
pH	7.20-8.29	6.98-8.36	6.92-8.37	7.10-8.64	-
DO (mg l ⁻¹)	4.05±0.15	3.99±0.14	3.84±0.14	4.00±0.12	1.087 ^{NS}
Hardness (mg l ⁻¹)	134.04±3.47	136.65±3.47	142.04±3.93	148.33±5.02	4.062**

*significant at 5% level, **significant at 1% level and NS indicates not significant.

Table 3. Growth, production and revenue of fish under different treatments

Treatment	Species	No. of fish stocked	Average weight at harvesting (g)	Gross production (kg)	Quantity (kg)	Production (kg/ha/6 months)	Value of fish (Rs)
T-1	C	200	205.30	24.430	159.183	1897.1	(@ Rs. 100/- per kg) 159183.00
	R	200	178.66	27.870	83	8	
	M	150	278.00	39.754			
	SC	200	240.00	47.040			
	GC	100	105.00	1.575			
	CC	150	176.33	18.514			
	AM	2000	2.66±2.01	30.535	30.535		
Total					189.718	2,35,520.50	
T-2	C	200	194.00	30.846	188.066	1953.5	(@Rs.150/- per kg) 10932.00
	R	200	193.33	35.379	66	4	
	M	150	236.00	33.748			
	SC	200	424.00	74.200			
	GC	100	84.60	2.453			
	CC	150	104.00	11.440			
	PS	2000	4.05±1.98	7.288	7.288		
Total					195.354	1,98,998.00	
T-3	C	200	56.66	8.555	148.649	1526.8	148649.00
	R	200	197.33	37.555	49	0	
	M	150	216.66	31.415			



Plate 1: Catch of mola



Plate 2: Catch of carps

Table 4. Biomass production and FCR of Fish in different Experimental ponds

Parameter	T-1	T-2	T-3	T-4
Total Feed Intake (kg)	392	392	392	392
Total Biomass Production (kg)	189.718	195.354	152.680	203.143
FCR	2.06	2.00	2.56	1.92
IMC Production (kg)	92.054	99.973	77.525	122.808
% IMC Production	48.52	51.17	50.77	60.45

Exotic Carp Production (kg)	67.129	88.093	71.124	80.335
% Exotic Carp Production	35.38	45.09	46.58	39.54
SIS production (kg)	30.535	7.288	4.031	-
% SIS production	16.09	3.73	2.64	-
Surface feeder Production (kg)	102.005	105.046	58.718	127.754
% Surface feeder Production	53.76	53.77	38.45	62.88
Column Feeder Production (kg)	29.445	45.120	42.548	36.552
% Column Feeder Production	15.52	23.09	27.86	17.99
Bottom Feeder Production (kg)	58.268	45.188	51.414	42.626
% Bottom Feeder Production	30.71	23.13	33.67	20.98
Max. Survival fish Species (%)	SC-98	M-95.3	SC,CC-100	SC-90
Min. Survival fish Species (%)	GC-15	GC-29	GC-70	CC-12

IMC: Catla, Rohu, Mrigal ;Exotic Carp: Silver Carp, Grass Carp, Common Carp; SIS: Mola, Puntius, Chela Surface Feeder: Catla, Silver Carp, Mola, Chela Column Feeder: Rohu, Grass Carp, Punthi Bottom Feeder: Mrigal, Common carp.

IV. DISCUSSION

Total fish production after six months of culture period in different treatments shows that the maximum total fish production was obtained in treatments where only carps were stocked, followed by carps and mola and least was obtained in treatment with carps and chela. The probable reason for the maximum weight gain by the Indian major carps in Treatment-4, where no small fish were stocked, was the lack of competition for space and food with the small indigenous fish species. It was also observed by Roy *et. al.*, 2003. In present study it was observed that inclusion of small indigenous fish in carp polyculture system has adversely affected the growth of Indian major carps, especially rohu and catla. Kohinoor *et.al.* 1998 found similar observation. A severe competition for food between planktivorous native carps and exotic carps has been observed by Dewan *et.al.* 1991. This might be due to the fact that mola and chela being surface feeder and puntius being column feeder competed for food and space with catla and rohu respectively (Kohinoor *et al.* 2000). The addition of the phytoplankton grazer mola (Miah and Siddique, 1992) reduced food availability for rohu. Catla feeds in the upper layers of the water column, mainly capturing zooplankton (Jhingran and Pulin, 1985). The addition of mola, puntius or chela which also grazes on phytoplankton but mainly feeds on the bottom and on detritus (Kohinoor, 2000), indirectly reduced food availability for catla reducing algal food of zooplankton, and puntius also by removing benthic stages of zooplankton. The addition of highly efficient grazer silver carp (Milstein, 1992) reduced food availability for all fish grazers. On catla this effect was produced indirectly through silver carp reduction of food availability for

zooplankton and directly through zooplankton removal. Puntius was affected due to silver carp removal of particles sedimenting onto the bottom on which puntius feed.

However, this adverse effect on growth of the fish was nullified by continuous supply of small indigenous fish for consumption and sell by the rural farmer families throughout the culture season. Wahab *et. al.* 2011 proved that manipulation of species composition is a useful tool to affect the pond ecosystem towards improving fish yield and corresponding income.

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