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Evaluation of production performance among three small indigenous fish species (SIS) *A.mola*, *E.dendricus* and *P.ticto* under different management systems for sustainable rural livelihood in Nepal

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Abstract : Fishes are important for the livelihoods, food and income source to the rural people in terai Nepal. To increase the carp fish production the common use of piscides and change in agricultural patterns in Nepal, there is the rapid decline in the population of small indigenous fish species (sis). The small indigenous fishes still plays an important role in the fulfillment of protein, vitamins and minerals to the rural poor in Nepal. Three small indigenous fish species*P* ticto, *A mola* and *E dendricus* which are largely found in warm water bodies of Nepal were examined for the production performance under monoculture and mixed culture system of the farm ponds of Janakpur Nepal for 127 days. The experiment was carried out for the finding of the best species of small indigenous fish species which can be reared with carp species in future.Three different treatments were undertaken, viz, treatment 1 was stocked with monoculture of *A mola,* treatment 2 was stocked with monoculture of *P ticto* and treatment 3 was stocked with *E dendricus* and ctrl (treatment 4) was stocked with mixed culture of *P ticto, A mola,* and *E dendricus.* The fish species were stocked @ 2000 ha^{-1} in treatments; T1, T2, T3 and all three sis species in mixed culture at the same proportion of 2000 ha^{-1} in the control ponds.The experiment was carried in CRBD design. Supplemental feed comprising of rice bran and mustard oil cake in the ratio of 2:1were supplied to three treatments and control ponds everyday throughout the study period. Ponds were fertilized with both organic and inorganic fertilizers. The results indicated that mixed culture of only sis gave a relatively high production of 1.335 kg/ha/yr,monoculture of *A mola* gave a production of 2.43 tons/ha and offers a better financial return.

Key words: SIS, Phytoplankton Mola Pothee Dedhuwa.

INTRODUCTION

The conservation and production potentials of large numbers of small indigenous fish of Nepal through aquaculture have remained unexplored. There are many small fish, such as punti (*Puntius* sp.), mola (*Amblypharyngodon mola*), and chela (*Chela lubuca*), that are unexplored for their production for freshwater aquaculture. SIS used to be abundantly available in rivers, streams, ponds, Potentials beels, ditches, and floodplains in the past, but these species have gradually been disappearing from the natural systems, which in turn severely affects biodiversity. These fish provide the main source of animal protein for all rural households, particularly low-income households. Special attention needs to be given to the culture of sis because they are important sources of vitamin A and minerals (Roos et al.2002)[1].Comparative studies show that the nutritional significance of sis is higher compared to larger fishes. The poor farmers participate in open water capture fishery either as temporary occupation or on accession so as to supplement nutrition and income for their livelihood. Despite the great importance of sis in Nepal, very few attempts have been made to study their biological aspects

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and culture potentials. Some preliminary studies have been conducted on *A mola*, *Gudusia chapra*, and *Colisha fasciatus* by Mustafa (1991)[2], Afroze and Hossain (1990)[3] have undertaken some experiments on *A mola* and other small indigenous fishes and Akhteruzzaman et al. (1998)[4] reported their preliminary attempt to culture *A mola*, *L bata*, and *Colisha fasciatus* sis in ponds of Bangladesh. *Amblypharyngodon mola, Esomus dendricus, Puntius shophore, Puntius ticto, Puntius sarana, Labeo dero* ,*Cirrhinus reba, Chanda nama* and *Colisha fasciatus* are the common sis species that grow in shallow ponds and rice fields in Nepal. They can breed in the stagnant water bodies. These species are normally cooked and eaten whole. Their effect on the diet is further enhanced since the bones also provide a source of calcium. The present study have been systematically conducted to assess the production potentials of three important sis, *Amblypharyngodon mola, Esomus dendricus* and *puntius ticto*, in monoculture and mixed culture systems.

MATERIALS AND METHOD

The growth and production performance of *P. ticto*, *A. mola* and *E. dentricus* was conducted in twelve earthen ponds of Janakpur ; each one pond was of approximately 100 m^2 (12.5 x 8 x 1.5m) size. The ponds were located in the government fish farm of Janakpur municipility. Janakpur is the district headquarters of Dhanusha district, Tarai Nepal. It is situated in 26.7 N latitude, 85.92 E longitudes and 66 m above sea level. The experiment was conducted from June to November 2012 for 127 days onward. Experimental design was carried out in CRBD (complete randomized block design) method. The experiment had three treatments; T1, T2, T3 and three replications. The monoculture of *A mola P ticto* and *E dendricus* were treatments T1, T2, T3 and the mixed culture of sis *A mola, P ticto, E dendricus* was ctrl (T4). The treatments were randomly allocated into the experimental ponds. All the experimental ponds were drained, dried and limed (CaO) at the rate of 250 kg/ha. Pond water filling was done up to 1.0m deep and fertilized with cow dung, urea and DAP @ 1000kg/ha, 12.5 kg/ha and 25 kg/ha respectively. SIS species were stocked after the fertilization of seven days. The stocking density of each one type of sis was 200000 fingerlings ha^{-1}in each treatment and control. The average stocking size of *A. mola, P. ticto* and *E . dendricus* were 1.5 gm, to1.0 gm. All ponds were subjected to treat with the same regime of feed and fertilizer application after of the post stocking management. The rice bran and mustard oil cake were used for supplementary feed into 2:1 ratio at the rate of 5% of body weight of standing crop. At the end of experiment all three species of sis were harvested, counted and weighed to estimate the weight gain from all experimental ponds. The survival percentage of three sis species were not estimated because of self recruiting habit of all experimental SIS in the pond water condition. The sechi disc visibility (transparency) was monitored fortnightly in each experimental pond of the treatments to adjust the use of fertilizers. Temperature, P^H, D.O, total alkalinity and free Co_2 were measured fortnightly of each one experimental pond. Composite water samples were collected fortnightly at 8.0 to 9.0 a m. The water temp, DO, and P^H were measured at the spot using digital DO meter (YSI Model-58 and pH by a digital pH meter (CORNING pH meter 445). The free CO_2 and total alkalinity of pond water was analyzed after APHA (1980)[5] and Boyd (1982)[6]. The water samples were also collected monthly for the analysis of phytoplankton's identification and enumeration. Identification of plankton to genus level was carried out using the keys from Ward and Whipple (1959)[7], Prescott (1962)[8] and Bellinger (1992)[9]. Plankton's number was estimated by following Azim (2001)[10].

RESULTS

Water Quality

The water quality parameters were found in within of suitable range for fish culture. The mean value of each one water quality parameter of all treatments was presented in table 1.1. The temperature record was found between 30.2 °c to 32.5 °c with the mean value 31.15 ± 0.51 in T_1. The water temperature was found between 30.2°c to 32.5 °c with the mean value 31.27 ± 0.31 in T2. The water temperature was found in between30.0°c to31.8°c with the mean value of 30.93 ± 0.38 and 30.0 °c to 32.2 °c with the mean value of 31.03 ± 0.45 in T_3 and T_4 (ctrl) respectively. The mean value of water transparency was shown in table 1.1. It was varied between minimum records of 19 cm to the maximum record of 33 cm. The mean value of water transparency was 24.70 ± 0.25, 25.93

±0.30, and 24.74 ± 0.006 and 24.70 ± 0.17 in T_1, T_2, T_3 and T_4 treatments. The experimental ponds of all treatments were always alkaline during the experiment period. The mean value of P^H in all treatments were recorded as; 7.55±0.061, 7.60 ± 0.076, 7.56 ± 0.068 and 7.66 ± 0.067 consequently in T_1, T_2, T_3 and T_4. The variation and mean value of P^H in all treatments and control was shown in table 1.1. The variation in DO in the whole experiment was form 4.2 mg/l 6.4 mg/l. The mean value of dissolved oxygen in all treatments; T_1, T_2, T_3 and T_4 were 5.52 ± 0.26, 5.28 ± 0.32, 5.50 ± 0.29, 5.62±1.874 table 1.1.The total alkalinity ranged from 75 to 121 mg/l during the experiment period (Table 1.1). The mean value of total alkalinity in all treatments T_1, T_2, T_3 and T4 were 93.30 ±1.73, 97.78 ±0.41, 93.15 ±0.06, 93.89 ± 0.18 respectively. The free CO_2 of pond water in experiment was recorded between10.0 mg/l to 14.2 mg/l with the mean value of all treatments. T_1, T2, T3 and T_4 consequently 12.24 ±0.52, 12.61 ±0.58, 12.34 ± 0.50 and 12.61±1.02 (Table 1.1).

Table 1.1 Water quality parameters in ponds of treatments T1, T2, T3 and T4

Treatments	Pond no.	Temperature C^0	Transparency (cm)	D O (mg/l)	pH	Total alkalinity (mg/l)	CO_2 (mg/l)
T1	P2	31.13 ± 0.3	24.88 ± 1.327	5.55 ± 0.159	7.54 ± 0.079	92 ± 5.011	12.3 ± 0.290
	P5	31.15 ± 0.301	25.11 ± 1.241	5.62 ± 0.151	7.56 ± 0.076	94.22 ± 5.24	12.21 ± 0.309
	P9	31.15 ± 0.308	24.11 ± 1.252	5.37 ± 0.195	7.53 ± 0.052	93.66 ± 5.37	12.21 ± 0.321
Mean		**31.15±0.51**	**24.70 ±0.25**	**5.52 ± 0.26**	**7.54 ± 0.016**	**93.30 ± 1.73**	**12.24 ± 0.52**
T2	P1	31.21 ± 0.286	25.55 ± 3.056	5.32 ± 0.179	7.64 ± 0.078	97.22 ± 4.54	12.42 ±0.654
	P4	31.26 ± 0.333	25.55 ± 3.137	5.26 ± 0.195	7.53 ± 0.104	97.33 ± 4.72	12.83 ± 0.553
	P8	31.32 ± 0.322	26.66 ± 3.415	5.25 ± 0.202	7.61 ± 0.084	98.77 ± 5.19	12.57 ± 0.592
Mean		**31.27 ± 0.31**	**25.93 ±0.30**	**5.28± 0.32**	**7.60 ± 0.139**	**97.78 ± 0.41**	**12.61 ± 0.58**
T3	P3	30.91 ± 0.212	24.66 ± 1.433	5.55 ± 0.172	7.57 ± 0.140	93.22 ± 4.6	12.23 ± 0.261
	P6	30.94 ± 0.220	24.66 ± 1.462	5.48 ± 0.180	7.55 ± 0.175	93.22 ± 5.1	12.42 ± 0.273
	P7	30.94 ± 0.220	24.88 ± 1.611	5.46 ± 0.172	7.54 ± 0.091	93.0 ±4.941	12.36 ± 0.356
Mean		**30.93 ± 0.38**	**24.74 ± 0.06**	**5.50 ± 0.29**	**7.56 0.125**	**93.15 ± 0.06**	**12.34 ± 0.50**
T4	P10	31.04 ± 0.248	25.11 ± 1.494	5.76 ±1.922	7.7 ± 0.150	94.33 ± 4.72	12.12 ± 0.405
	P11	31.03 ± 0.266	24.55 ± 1.191	5.68 ± 1.896	7.63 ± 0.147	93.66 ± 4.47	12.32 ±0.307
	P12	31.01 ± 0.267	24.44 ± 1.454	5.41 ± 1.803	7.63 ± 0.095	93.67 ± 4.46	13.38 ± 1.263
Mean		**31.03 ± 0.45**	**24.70 ± 0.17**	**5.62 ± 1.874**	**7.66 ± 0.124**	**93.89 ± 0.18**	**12.61 ± 1.02**

Plankton Population

The total number of phytoplankton species and their abundance during the experimental period was shown in table 1.2. Altogether four group of phytoplankton was recorded in the experiment; Chlorophyceae, Cyanophyceae, Euglinophyceae and Bacillariophyceae. The Chlorphyceae group contained 15 genera, Cyanophyceae 3 genera, Bacillariophyceae 5 genera and Euglinophyceae 2 genera over the Chorophyceae as dominant group in the present study. The dominant phytoplankton species in all treatments was Chlorella in the present study and it was followed by Euglina.

Fish growth and production

The growth and production performance of three selected species of sis, *P. ticto, A.mola and E. dendricus* was shown in table 1.3. The mean individual stocking weight of *P. ticto* in all the treatments and control was 1.5 gm and 1.4 gm. The mean individual harvesting weight of

Table 1.2 Mean value of phytoplankton abundance (units^{-L}) in all treatments

Treatments				
Group / Genus	T1	T2	T3	T4 (ctrl)
Chlorophyceae				
Chiorella	10362	9729	9435	10017
Closterium	1018	1012	990	1041
Zygnema	189	185	198	165
Actinastrum	394	381	390	408
Cladophora	121	121	127	141
Chlamydomonas	304	308	294	290
Oedogonium	102	98	111	120
Netrium	123	127	127	135
Pediastrum	201	212	185	205
Selenastrum	54	54	52	64
Spirogyra	488	398	482	432
Tetraedron	245	235	228	252
Tetraspora	155	155	176	210
Volvox	27	26	20	31
Ulothrix	64	68	62	76
Mean ± (S.E)	3461.75±2439.61	3277.25± 2281.04	3219.25±2197.60	3396.75±2340.612
Cyanophyceae				
Anabaena	55	61	70	72
Microcystis	5541	4857	4800	4652
Oscillatoria	488	470	447	494
Mean ± (S.E)	1521±518.31	1347±454.67	1329.25±445.212	1304.5±435.75
Euglenophyceae				
Euglina	9631	7128	6054	6862
Phacus	419	413	430	501
Mean ± (S.E)	2512.25±2516.86	1885.25±1853.592	1621±1567.302	1840.75±1775.28
Bacillariophyceae				
Fragillaria	1837	1898	1826	2021
Diatoma	198	181	207	219
Synedra	1653	1725	1744	1811
Cyclotella	136	112	127	120
Cymbella	1866	1795	1802	1825
Mean ± (S.E)	1422.5±146.547	1427.75±166.258	1426.5±141.244	1499±184.554

P. ticto in T2 was 3 gm, 2.5 gm and 2.7 gm. The survival percentage of *P. ticto* was not carried out as the fish species breed two times during the study period. The net yield of fish *P. ticto* in T2 was 5.52±0.198 kg.

The mean individual stocking weight of mola was 1.36±0.072, 1.3±0.094 and 1.33±0.072 gm in the ponds of treatment T1. As the mola breeds under pond condition, so the survival percentage was not carried out in the result of experiment. The net yield of mola was7.11±0.291 kg in T1. The individual harvesting weight of mola was 2.9 gm 3 gm, 3.2 gm.The mean individual stocking weight of *E. dendricus* (dedhuwa) was 1.0±0.094, 1.06±0.072 and 1.1±0.124 gm in treatmentT3. The individual harvesting weight of dedhuwa was 2.1, 2.2 and 2.6 gm. The survival percentage of *E. dendricus* was not carried out as the fish species breed into pond condition. The net yield of *E. dendricus* (dedhuwa) was the lowest among all three species of sis. The net yield of *E. dendricus* was 5.14±0.471. (Table-1.3). The mean stocking weight of mola in the ponds of treatment 4 (ctrl) was 1.36±0.072, 1.3±0.094, 1.33±0.072 gm, *P ticto* was 1.5±0.124, 1.4±0.047, 1.5±0.094 gm and *E. dendricus* was 1.0±0.094, 1.06±0.072 and 1.1±0.124 gm. The mean individual harvesting weight of mola, *P ticto* and E. *dendricus* in treatment T4 were 2.7, 2.9, 3.1 gm, 2.8, 2.7, 2.4 gm, and 1.9, 2.0, 2.3 gm. The net yield of mola, *P ticto* and E. *dendricus* in all three treatments were 7.11±0.291, 5.52±0.198 and 5.14±0.471 kg. The mean net yield of sis species *A mola*, *P ticto* and E. *dendricus* in T4 were. 5.88±0.404 kg, 5.25±0.422 kg, and 3.90±0.243 kg/ 100 m ^{2}. All three species of sis stocked number were much more than total number of harvesting so the survival percentage of any one species was not carried out in T4.

DISCUSSION

The water quality parameters were found within the suitable range for all SIS species in all treatments. The water temperature never rose above 32^{0}c and below of 23^{0}c during the experimental period. Similar observations were recorded from Paliwan et al, (2008)[11] in the tanks of Kolhapur and Paul 1998[12] in the ponds of B A U Mymensigh Bangladesh. They recorded water temperature 26.7-33.7^{0}c, 26-32.4^{0}c and 18.5-32.9^{0}c respectively in the ponds used for fish culture. The transparency of pond water in all treatments were within the suitable range i.e. never more than 30 cm and less than 21 cm. the variation in transparency would be due to abundance of planktons. The transparency ranged between 15-40 cm is regarded as appropriate for fish culture, Boyd (1982)[6]. The P^H value of pond water was always recorded between 7.5 to 8.5. Swingle 1967[13] and Boyd 1982[6] recommended, P^H value ranging from 7.0 to 9.2 as the suitable for fish culture. The dissolved oxygen (DO) was comparatively good in all treatments; within the range of 6.13±0.54 to 7.03±0.63 mg/l. The planktonic density might be responsible for accelerated rate of photosynthesis in the experimental ponds of all treatments. Banargee et al. , (1990)[14] stated that pond water DO within 5.0 to 10.0 PPM is considered as the ideal for fish production. Openheimer et al., (1978)[15], Wahab et al., (1995)[16] and Roy et al, (2002)[17] recorded similar D O values like to be the present study; 3.18 - 7.58 mg/l, 2.2-7.1 mg/l and 3.65-7.65 mg/l respectively from the ponds of Bangladesh. The total alkalinity ranged from 75 to 115 in T_1, 76 to 121 T_2, 76 to 118 T_3 and 74 to 118 T4. The mean value of total alkalinity in T_1, T_2, T_3 and T_4 were typically found within the suitable range for fresh water fish culture (Oppenheinmer et al., 1978)[15]. The free CO_2 in all treatments, T_1, T_2, T_3 and control (T_4) were within the suitable range. Hynes (1970)[18] stated that in order of safeguard of fisheries interest 25 mg/l of free carbon dioxide has been recommended as upper limit.

Phytoplankton density (units/l) was recorded maximum in treatment T3 and minimum in treatment T2. The phytoplankton diversity was represented by 25 species belonged to class chlorophyeae, bacillariphycae, cyanophycae and Euglinophyceae (Table 1.2).The highest number 13 species of phytoplankton was found from the class cholorophycace and the lowest number of only 2 species was recorded from the class, Englenophycae. There were no significant differences in Phytoplankton densities among the treatments (P>0.05, Table 1.2). Mean total phytoplankton (units^{-L}) ranged from 3461.75±2439.61, 3277.25± 2281.04, 3219.25±2197.60 3396.75±2340.612 in T1, T2, T3 and T4 from class chlorophyeae 1521±518.31, 1347±454.67, 1329.25±445.212, 1304.5±435.75 from class cyanophycae, 2512.25±2516.86, 1885.25±1853.592,

Table 1.3 Production performance of (sis) *A. mola* ,*P. ticto* , *E. dendricus* (Mean ± S.E)

Treatments	Fish species	Pond no.	At stocking			At harvesting			
			Av. Initial wt(g)	No. of fish stock	Initial total wt. kg/100 m^2	No. of fish recorded	Mean final wt(g/fish)	Final total wt.kg/100 m^2	Net yeild kg/100 m^2
T1	*A mola*	P2	1.36±0.072	2000	2.72	3150	2.9	9.135	6.415
		P5	1.3±0.094	2000	2.6	3320	3	9.96	7.36
		P9	1.33±0.072	2000	2.66	3200	3.2	10.24	7.58
Mean±S.E									7.11±0.291
T2	*P. ticto*	P1	1.5±0.124	2000	3	3000	3	9	6
		P4	1.4±0.047	2000	2.8	3200	2.5	8	5.2
		P8	1.5±0.094	2000	3	3100	2.7	8.37	5.37
Mean±S.E									5.52±0.198
T3	*E. dendricus*	P3	1.0±0.094	2000	2	3030	2.1	6.363	4.363
		P7	1.06±0.072	2000	2.12	3150	2.2	6.93	4.81
		P6	1.1±0.124	2000	2.2	3260	2.6	8.476	6.276
Mean±S.E									5.14±0.471
T4 (ctrl)	*A mola*	p12	1.36±0.072	667	0.907	1940	3.8	7.372	5.648
		p11	1.3±0.094	667	0.867	1880	3.5	6.58	5.713
		p10	1.33±0.072	667	0.887	2025	3.6	7.29	6.403
	Mean								6.193±0.196
	P ticto	p12	1.5±0.124	666	0.999	1830	3.6	6.588	5.589
		p11	1.4±0.047	666	0.932	2010	3.5	7.035	6.103
		p10	1.5±0.094	666	0.999	1970	3.5	6.895	5.896
	Mean								5.862±0.121
	E dendricus	p12	1.0±0.094	667	0.667	1920	2.8	5.376	4.709
		p11	1.06±0.072	667	0.707	2150	2.6	5.59	4.4883
		p10	1.1±0.124	667	0.733	1840	2.7	4.968	4.235
	Mean								4.609±0.158
Mean±S.E									5.511±0.036

1621±1567.302 and 1840.75±1775.28 from class Euglinophyceae and 1422.5±146.547, 1427.75±166.258, 1426.5±141.244,and1499±184.554 from class bacillariphycae.

The combined gross productions *A. mola* was significantly higher ($P<0.05$) in treatments T1(2.043 ton $ha^{-1}yr^{-1}$) than in treatments T3 (1.477ton $ha^{-1}yr^{-1}$) and no significant differences noticed between treatment T2 (1.586 ton $ha^{-1}yr^{-1}$), and T3 (1.477ton $ha^{-1}yr^{-1}$) (Table1.3). The production and growth of mola species was the highest in treatment T1 in comparison of the control T4 indicates that mola has negative impact on the growth and production with the other SIS species *P. ticto* and *E. dendricus* might be due to overlapping feeding nich . Ameen et al., (1984)[19] have reported similar result from his experiment in which the growth and production performance of *puntius sarana* negatively affected the growth of mola in composite culture. The mean net yield of mola from monoculture in T1 was 2.043 tons/yr in present study which is higher than the finding of Ameen

et al., (1984)[19] 1.75 tons/ha/8 months. Mustafa (1991)[2] obtained a production of 4 to 5 tons/ha/year of *A mola, P. chola* and *Colisa fasciatus* in the composite culture experiment of small indigenous fishes in Bangladesh which is lower than the production performance of *A mola, P. ticto* and *E dendricus* in the monoculture and composite culture experiment of present study. The low production performance of three SIS species of present study in comparison of the result of Mustafa (1991)[2] was perhaps due to the selection of different type of sis species P ticto and E dendricus in spite of *P. chola* and *Colisa fasciatus* in the present experiment. The mean net yield of, *puntius* and *Esomus* in the present study did not show the significant differences (P>0.05).

All three species of SIS during the culture period were found to breed in the ponds. The mola breed in March and May two times in present study period. Afroze and Hossain (1990)[3] reported that the breeding season of A mola starts from May and continued till October with the peak in August in Bangladesh.

CONCLUSION

The small indigenous fish species SIS were very common in the past were now captured in less quantity. The SIS are micronutrient enriched fish species in comparison of carp species. The *A. mola* can be reared with carp species together after standardizations with carp combinations and developing the appropriate stocking density because of the high production performance result obtained from present experiment among three SIS species.

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