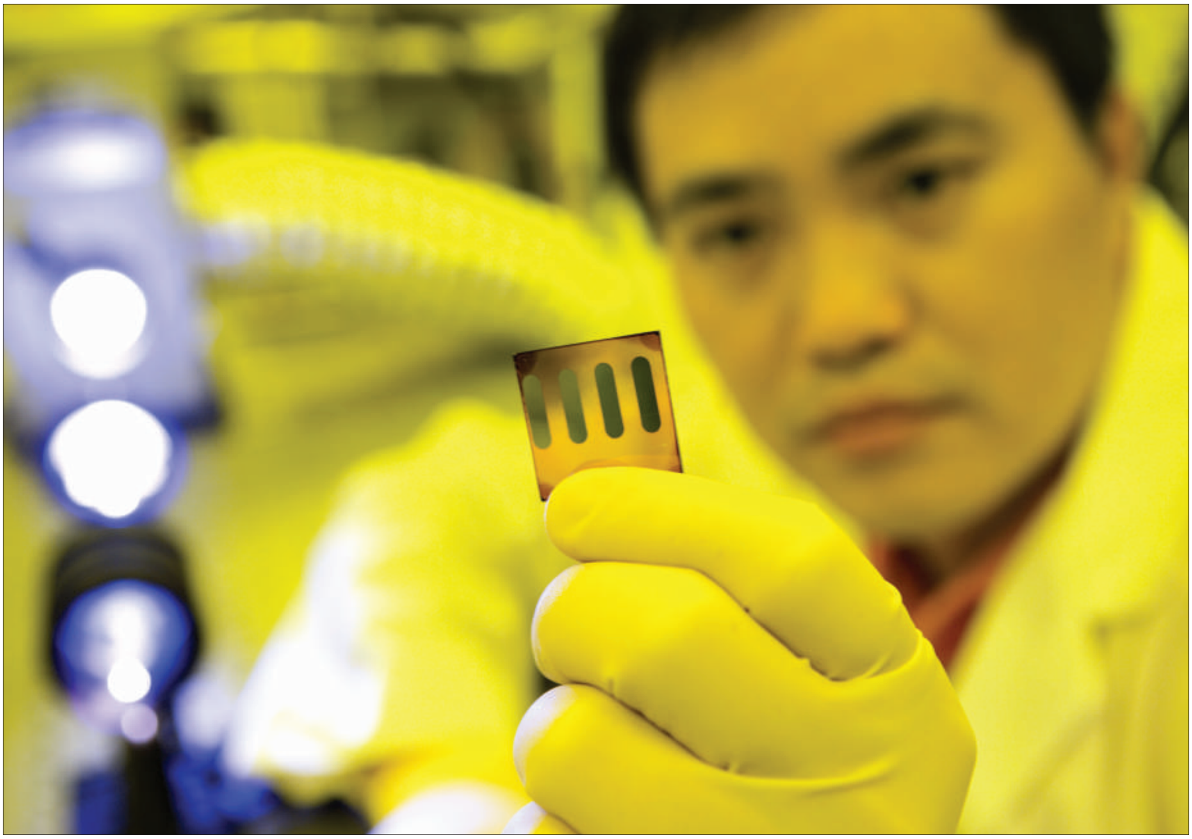

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# Research Article
# Enhance the Contribution of Small Indigenous Fish Production: Emphasis Mola (*Amblypharyngodon mola*) with Carps in North-West of Bangladesh

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## Abstract

**Background and Objective:** Eco-climatic condition is highly favorable to conduct the aquaculture farm operation in Riverine Bangladesh and recently aquaculture became a profitable and nutritious source of agriculture and this study conducted to enhance the production of small indigenous fish with carps in Bangladesh. **Materials and Methods:** An on-farm experiment was carried on 240 days during April-December, 2012 at North-west Bangladesh to produce more small fish with the carps. All of the household ponds (200-600 $m^2$) were stocked with the fingerlings of *Labeo rohita*, *Catla catla*, *Cirrhinus cirrhosus*, *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella*, *Labeo bata* and *Amblypharyngodon mola* at different rate. There were three treatments and interfering the period of culture varied the production frequency of mola which produced more or less in the experimental ponds. **Results:** All the recorded water quality parameters varied significantly differences ($p>0.05$) among the treatments except transparency and dissolved oxygen. The growth performance of all the carps, silver carp was the first growing and bata was the lowest. The total fish production was the highest (3783.30 kg $ha^{-1}$) in early stocking (EST) and the lowest (2836.61 kg $ha^{-1}$) in existing stocking (EXST) treatment, but the total small fish production (55%) was higher in the EXST ponds than seasonal stocking (SST) and EST ponds. The highest SGR and the rate of survival of carps were higher in SST than the other treatments. **Conclusion:** Poly-culture of carps with mola can provide additional nutritional and economic benefits; field level household culture is highly suggested in Bangladeshi pond.

Key words: Culture period intervention, small indigenous species, polyculture, *Amblypharyngodon mola*, stocking ponds

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Small fish is considered those fish which grow to a maximum length of about 25 cm at maturity[1]. In Bangladesh, there are more than 260 species of fish of these only a few of the larger indigenous varieties mainly craps are under culture, while more than 50 species play an important role in the national diet of Bangladesh[2]. Small indigenous fishes of Bangladesh are available in water bodies like drains, ditches, ponds, lakes, rice-fields, beels, haors, baors and rivers, etc. There are different small indigenous fishes in our country among them koi, vedha, pabda, gulsa, tengra, mola, darkina, chela, puti, chanda and guchi etc., are the most common species[3]. The distribution areas of the small fishes are very wide ranges. They are generally found in the neglected fallow water areas and margins of agricultural lands, roads and houses where large fishes cannot survive[1,4]. These small indigenous fishes have a high nutritional value in terms of both protein content and presence of micronutrients, vitamins and minerals[5]. In Bangladesh, around 45.7% of children between the ages of 6-7 months are underdeveloped and 70% are exhausted due to malnutrition. Some small fishes like mola, darkina are rich in essential micro and macro nutrients which prevent night blindness and anaemia of children and women[6]. Improvement of management techniques, better knowledge about the biology of different aquatic species, tremendous advance in feed technologies for aquatic organisms, better health management and treatment of diseases together have contributed to such a sustained increase in the global aquaculture production[7,8]. Today, aquaculture has increased its contribution to world fishery and estimated itself as one of the fastest growing food production sector in the world[9]. Small fishes are regarded as undesirable species in aquaculture management practices. These are mostly eradicated using rotenone and other pesticides. There is little information on how those large fish, that is, carp-based production systems have been contributing to the overall nutrition of the people of Bangladesh. It is assumed that due to the unavailability of the small fish, the poor and under-privileged people have been facing serious malnutrition problem[10]. The drastic reduction of small fish in the market in early 1990s, once again made the necessity of culturing and conservation of small fishes in this country. Now a day, the culture and research of small indigenous species has been gradually gaining attention[11-22]. There has been a great demand of small fishes such as mola, puti, kholisa, darkina and tengra in the rural as well as urban markets. To ensure the supply of SIS to the rural households, a modified polyculture technology with large carps and SIS in the same ponds should be introduced. Before one decades rural people thinks from the carp-SIS culture provides carps as a cash crop and small species mola as food for family consumption. Now the situation is improving, so it would be a right step to make maximum use of the available fisheries resources due to produce more small fishes of the country as for cash crop and also family nutrition. Considering above mentioned prospect and constraints this study has been conducted to enhance the production of small indigenous fish especially *Amblypharyngodon mola* with carps in North-west of Bangladesh.

## MATERIALS AND METHODS

**Study area:** The experiments were performed simultaneously in 54 farmer's household ponds, in three upazilas named Parbatipur, Chirirbandar and sadar of Dinajpur districts. It was the North-west region of Bangladesh.

**Experimental design:** The experiment was consisted three treatments depending on the period of stocking (last week of April and continued up to last week of December, 2012). It was performed in total 54 household farmer's ponds (avg. size varied 200-600 m$^2$) with 18 replicates of each treatment in Dinajpur district (Table 1).

**Stocking and management:** Before initiation of the experiment, undesirable aquatic weeds were removed, embankments and slopes also repaired. All the ponds were applied at lime ($CaCO_3$) 250 kg ha$^{-1}$ and cowdung 1000 kg ha$^{-1}$. One week after liming, the ponds were fertilized at urea 20 and TSP 10 kg ha$^{-1}$ to stimulate the productivity of the ponds. One week after fertilizing, the ponds were stocked with the fingerlings of Indian major and minor carps, rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus cirrhosus*),

Table 1: Experiment design for the present study

| Parameters | Early stocking | Seasonal stocking | Existing stocking |
|---|---|---|---|
| Culture period | 240 days | 150 days | 240 days |
| Months | April and continued up to December | July-December | April-December |
| Water sources | Deep tube-well | Rain | Rain |
| Mola stock | New stock | Seasonal stock | Existing stocking |

Table 2: Stocking characteristics with 18 replicates (species composition in number and mean weight)

| Treatments | | | | | | |
|---|---|---|---|---|---|---|
| | EST (avg. 536 $m^2$) | | SST (avg. 276 $m^2$) | | EXST (avg. 422 $m^2$) | |
| Fish species | Number (1 $m^{-2}$) | Weight (g) | Number (1 $m^{-2}$) | Weight (g) | Number (1 $m^{-2}$) | Weight (g) |
| **Carps** | | | | | | |
| Rui (25%) | 134 | 12.50 | 69 | 11.67 | 106 | 15.89 |
| Catla (15%) | 80 | 20.00 | 41 | 12.11 | 63 | 14.72 |
| Mrigal (25%) | 134 | 15.22 | 69 | 16.00 | 106 | 15.56 |
| Silver carp (20%) | 107 | 16.56 | 55 | 15.33 | 84 | 15.33 |
| Grass carp (5%) | 27 | 18.28 | 14 | 14.22 | 21 | 14.78 |
| Bata (10%) | 54 | 17.89 | 28 | 10.78 | 42 | 10.61 |
| **Small fish** | | | | | | |
| Mola | 150 g, NC | 1.83 | 150 g, NC | 1.67 | 150 g, NC | NS |

EST: Early stocking, SST: Seasonal stocking, EXST: Existing stocking, NC: Not counting, NS: Not stocking

silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), bata (*Labeo bata*) and mola (*Amblypharyngodon mola*), respectively (Table 2).

Most of the freshwater pond fish farming systems in Bangladesh are either extensive or improved extensive and in very few cases intensive. In improved extensive culture system in ponds are stocked mainly with Indian major carps and exotic carps are cultured in polyculture system in ponds. All ponds were applied with very small amount of feed ingredients and fertilizers. Inputs were supplied from farmers household. Fishes were sampled (10 fishes of each species) by seine net at monthly intervals to assess their growth (length and weight) by measuring scale and electronic balance (HC-K5KA), respectively. After three months from stocking large carps were harvested small amount twice or thrice in a month for household consumption, but farmers used to record properly. Partial harvesting of mola started two months after stocking for family consumption or sold as brood fishes and total fish harvesting was carried out on last week of December 12. At final harvesting all large fishes were weighted separately but mola was bulk weighted and add all the partial harvesting.

**Water quality monitoring:** The first water quality samplings were recorded before fishes stocked. Water sampling of each pond was performed every month between 9:00 and 11:00 AM. Water temperature was recorded with a Celsius thermometer. Transparency was measured with a Secchi disc of 20 cm diameter. Alkalinity and DO of water samples were measured by Portable kit (HANNA). The pH was also measured by pocket pH meter (HANNA).

**Statistical analysis:** Water quality parameters, planktons and fish production data were recorded and analyzed using Microsoft Excel 2007 and PASW Statistics 18 (Predictive Analytics Software, formerly named SPSS)[23]. One way Analysis of Variance (ANOVA) and Tukey's multi comparison test used to determine differences between treatments means at a significance level of $p<0.05$. The standard errors, means of treatments estimated.

## RESULTS

**Water quality parameters:** The ANOVA results and mean multi-comparisons by treatment of each water quality parameters are summarized (Table 3). From the result of the repeated measures analysis of different treatments, it was revealed that transparency and DO did not show significant differences ($p>0.05$). Other temperature, pH and alkalinity were fluctuated significantly with the sampling date. All parameters were accounted for a relatively low portion of the data variability. The covariate pond area did not significantly affect water quality.

**Fish performance:** The ANOVA and mean multi-comparison results of growth performance, survival, SGR and production of all carps and mola showed rui was not affected by the polyculture composition with SIS mola. Individual harvesting weight was lower at the rate of 16, 16 and 13% from the bottom feeder, mrigal in EST, SST and EXST, respectively. The survival and production of rui were 5 and 12% lower than mrigal in same EST treatment. The ANOVA model was significant at $p<0.01$ for all variables and the individual stocking weight, survival and gross production were counted their variability (Table 4).

Catla was affected in polyculture composition with silver carp. Because of the nature of their surface feeder food habit are same. The stocking densities of catla were increased 10% than silver carp in the experiment. The highest production treatment (EST) harvesting weight and SGR was lower than

Table 3: Mean values (±SE) and range of some water quality parameters in different treatments

| Parameters | EST | SST | EXST | F-value | Level of significance/$r^2$ |
|---|---|---|---|---|---|
| Temperature (°C) | 26.80±0.34[a] (14.00-36.00) | 24.85±0.48[b] (14.00-31.00) | 27.97±0.40[a] (14.00-36.00) | 13.588 | 0.013*** |
| Transparency (cm) | 29.22±0.36 (20.00-39.00) | 28.14±0.35 (21.00-41.00) | 28.48±0.32 (21.00-40.00) | 2.416 | 0.007[NS] |
| DO (mg $L^{-1}$) | 5.48±0.08 (3.10-7.50) | 5.38±0.09 (3.10-7.30) | 5.72±0.08 (3.20-8.20) | 2.864 | 0.012[NS] |
| pH | 7.93[ab] (6.78-9.18) | 7.94[a] (7.02-9.01) | 7.78[b] (7.02-9.10) | 3.927 | 0.015* |
| Alkalinity (mg $L^{-1}$) | 101.05±2.00[ab] (52.00-143.00) | 95.66±1.75[a] (53.00-135.00) | 103.27±1.59[a] (57.00-143.00) | 3.824 | 0.002* |

EST: Early stocking, EST: Seasonal stocking, EXST: Existing stocking, Mean values with different superscripts in each row indicate a significant difference (p<0.05) based on Tukey's test, significance level: (+) p<0.1, *p<0.05, **p<0.01, ***p<0.001, NS: Not significant (p>0.05), $r^2$: Coefficient of determination

Table 4: Mean (±SE) multi comparison of yield parameters of rui, catla, mrigal, silver carp, grass carp, bata and mola in different treatments

| Species/treatments | Early stocking | Seasonal stocking | Existing stocking | Level of significance/$r^2$ |
|---|---|---|---|---|
| **Rui** | | | | |
| Individual stocking weight. (g) | 12.50±0.57[b] | 11.66±0.48[b] | 15.89±0.27[a] | 0.278*** |
| Individual harvesting weight (g) | 278.11±12.92[a] | 243.44±8.23[b] | 275.83±5.15[a] | 0.000** |
| Survival (%) | 85.00±1.08[a] | 87.11±1.09[a] | 53.44±2.07[b] | 0.604*** |
| SGR (% $day^{-1}$ b.wt.) | 1.29±0.02[b] | 2.02±0.03[a] | 1.18±0.09[c] | 0.012*** |
| Gross yield (kg $ha^{-1}$) | 584.05±28.38[a] | 523.48±18.46[b] | 363.12±14.25[b] | 0.498*** |
| Net yield (kg $ha^{-1}$) | 553.18±28.14[a] | 494.66±18.32[a] | 323.88±13.98[b] | 0.517*** |
| **Catla** | | | | |
| Individual stocking weight (g) | 18.22±0.66[a] | 12.11±0.49[c] | 14.72±0.42[b] | 0.183*** |
| Individual harvesting weight (g) | 333.72±22.93[a] | 271.33±6.90[b] | 333.78±16.59[a] | 0.000** |
| Survival (%) | 80.72±1.26[a] | 84.05±1.20[a] | 54.44±1.39[b] | 0.565*** |
| SGR (% $day^{-1}$ b.wt.) | 1.20±0.02[b] | 2.08±0.03[a] | 1.29±0.03[b] | 0.009*** |
| Gross yield (kg $ha^{-1}$) | 399.03±27.73[a] | 377.13±7.62[b] | 266.89±12.19[c] | 0.345*** |
| Net yield (kg $ha^{-1}$) | 372.03±27.45[a] | 319.18±7.63[a] | 245.07±12.17[b] | 0.329*** |
| **Mrigal** | | | | |
| Individual stocking weight (g) | 15.22±0.43 | 16.00±0.46 | 15.56±0.45 | 0.005[NS] |
| Individual harvesting weight (g) | 332.55±16.39 | 293.17±16.90 | 315.39±18.00 | 0.009[NS] |
| Survival (%) | 81.17±1.39[a] | 83.05±1.14[a] | 54.38±1.47[b] | 0.591*** |
| SGR (% $day^{-1}$ b.wt.) | 1.30±0.02[b] | 1.92±0.03[a] | 1.24±0.02[b] | 0.002*** |
| Gross yield (kg $ha^{-1}$) | 666.56±34.60[a] | 601.49±34.5[a] | 421.02±24.13[b] | 0.362*** |
| Net yield (kg $ha^{-1}$) | 628.97±34.92[a] | 561.97±34.49[a] | 382.59±23.81[b] | 0.365*** |
| **Silver carp** | | | | |
| Individual stocking weight (g) | 16.55±0.66 | 15.33±0.53 | 15.33±0.03 | 0.036[NS] |
| Individual harvesting weight (g) | 495.14±33.90[a] | 334.22±10.46[b] | 393.33±19.32[b] | 0.127*** |
| Survival (%) | 77.22±1.14[b] | 87.88±0.89[a] | 62.11±1.28[c] | 0.286*** |
| SGR (% $day^{-1}$ b.wt.) | 1.40±0.04[b] | 2.05±0.03[a] | 1.34±0.02[b] | 0.004*** |
| Gross yield (kg $ha^{-1}$) | 757.52±54.55[a] | 579.50±17.73[b] | 478.11±30.12[b] | 0.350*** |
| Net yield (kg $ha^{-1}$) | 724.80±55.16[a] | 549.97±17.60[b] | 447.81±29.71[b] | 0.345*** |
| **Grass carp** | | | | |
| Individual stocking weight (g) | 20.00±0.59[a] | 14.22±0.45[b] | 14.78±0.42[b] | 0.416*** |
| Individual harvesting weight (g) | 329.94±22.85 | 306.05±6.90 | 298.67±6.84 | 0.044[NS] |
| Survival (%) | 77.83±1.65[a] | 79.83±1.56[a] | 61.17±1.57[b] | 0.409*** |
| SGR (% $day^{-1}$ b.wt.) | 1.15±0.03[c] | 2.04±0.02[a] | 1.25±0.14[b] | 0.010*** |
| Gross yield (kg $ha^{-1}$) | 124.38±6.95[a] | 120.58±3.33[a] | 89.92±2.45[b] | 0.325*** |
| Net yield (kg $ha^{-1}$) | 114.50±6.90[a] | 113.55±3.34[a] | 82.63±2.40[b] | 0.290*** |
| **Bata** | | | | |
| Individual stocking weight (g) | 13.83±0.48[a] | 10.77±0.47[b] | 10.61±0.39[b] | 0.307*** |
| Individual harvesting weight (g) | 120.89±9.25 | 105.22±1.49 | 112.39±1.53 | 0.022[NS] |
| Survival (%) | 78.11±1.35[b] | 81.72±1.01[b] | 62.94±1.61 | 0.394*** |
| SGR (% $day^{-1}$ b.wt.) | 0.89±.02[c] | 1.53±0.03[a] | 0.99±0.02[b] | 0.017*** |
| Gross yield (kg $ha^{-1}$) | 93.22±7.04[a] | 84.88±1.32[a] | 69.97±2.18[b] | 0.219*** |
| Net yield (kg $ha^{-1}$) | 79.55±6.95[a] | 74.23±1.50[a] | 59.49±2.29[b] | 0.173** |
| **Mola** | | | | |
| Individual stocking weight (g) | 1.83±0.17 | 1.67±0.18 | 2.22±0.20 | 0.039[NS] |
| Individual harvesting weight (g) | 4.05±0.34 | 4.27±0.37 | 4.39±0.32 | 0.009[NS] |
| Gross yield (kg $ha^{-1}$) | 865.46±20.13[a] | 609.13±20.19[b] | 456.26±32.26[c] | 0.715*** |
| Net yield (kg $ha^{-1}$) | 828.41±20.13[a] | 572.08±20.13[b] | 456.26±32.26[c] | 0.665*** |

Mean values with different superscripts in each row indicate a significant difference (p<0.05) based on Tukey's test, significance level: (+) p<0.1, *p<0.05, **p<0.01, ***p<0.001, NS: Not significant p>0.05, $r^2$: Coefficient of determination

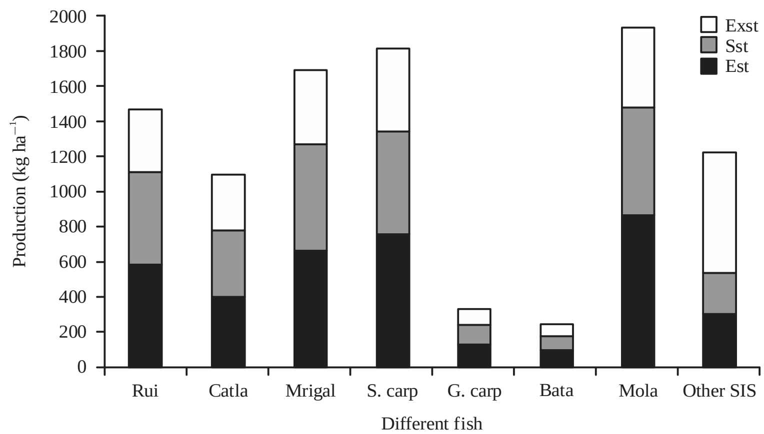


Fig. 1: Total production of different species between the treatments
EST: Early stocking, EST: Seasonal stocking, EXST: Existing stocking

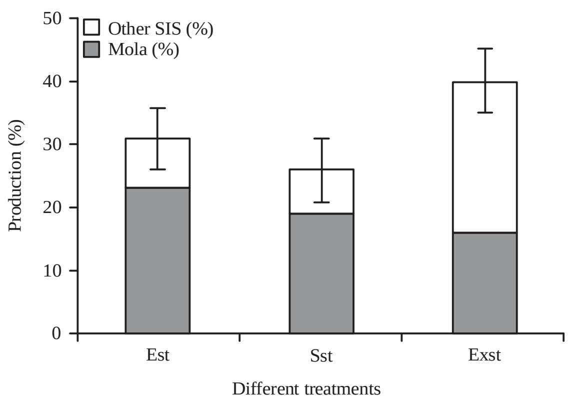


Fig. 2: Contribution of small fishes from the total production among the treatment
EST: Early stocking, EST: Seasonal stocking, EXST: Existing stocking

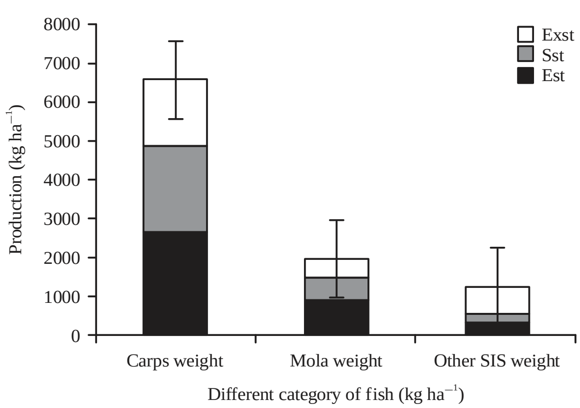


Fig. 3: Mean fish yield (±SE) with different category among the treatment
EST: Early stocking, EST: Seasonal stocking, EXST: Existing stocking

silver carp. Also, in same treatment survival and production were found different than plankton feeder silver carp. All the growth parameters were significantly different ($p<0.01$) and the variability recorded for the production and survival.

Mrigal is the bottom feeder or bottom dweller is the suitable for polyculture. In the three treatments individual harvesting weight were higher 19, 20 and 14% than rui fish, respectively. The SGR of mrigal is 5% higher than rui in short period of treatment.

All of the carps, grass carps were stocked low amount (5%). It was stocked 50% of bata fish but the end of experiment its harvesting weight was 2.73 times higher than bata in the highest growth treatment. In EXST treatment, total production was 29% higher than bata.

Bata is very ordinary species in polyculture of that region. At stocking among in the short period of treatment (SST) bata is 50% of grass carp and also production was lower about 25% than grass carp in EST. The SGR was 23% lower than grass carp in same EST treatment. Individual harvesting weight varied no significant differences among the other growth parameters both in bata and grass carp. Except individual harvesting weight of all the growth parameters were significantly different ($p<0.01$) and the variability recorded 30-40% for the stocking weight, production and survival. Among the all fish species, bata is the lowest production of all the treatments.

Table 4 represents the ANOVA model and multi-comparison results the variability was counted gross production 72% and net production 67%. Mola bred in all ponds, was not affected in polyculture but also help to increase the other SIS production as well. In the three categories of fishes mola production was the second highest. In the highest amount of total small fish production (40%) in EST treatment, mola contribute 16% and other SIS 24%. The overall production of these system is shown in Fig. 1-3.

## DISCUSSION

In the present study, monthly average growth rate of fishes was found to increase more or less rapidly at the beginning of the experiment and then slowly after October till end of the experiment. Relatively slower growth rate towards the end of the experiment might be associated with the winter season. The ecology of ponds was dominated by changes in time, strongly related to the development of increasing temperature and to weather condition. As the expected SIS had practically no effect on the other fish if the optimum stocking density of the small fish to avoid competition with the large fish was determined in previous studies[24,25].

Rui is an omnivore with preference for debris decaying vegetation, which is partially related with the food habit of mola. Mustafa[26] and Kohinoor[27] reported that adult mola fish consume unicellular and filamentous algae, zooplankton, debris and plant parts. However, the presence of grass carp increased the production of mrigal. Mrigal is mainly a bottom feeder that feeds on detritus, plants and zooplankton, but also migrates throughout the water column to feed in shallow areas[28]. It may be due to greater availability of semi-digestive micro-pelleted vegetation from the excreta of grass carp. There were no significant differences in the growth, survival and production of catla among the treatments. Although both catla and mola, are surface feeders, they exert lesser competition for food between them, because catla is mainly a zooplankton grazer[2,29,30] and molas prefer phytoplankton[31,32]. Alam *et al.*[33] investigated culture of mola with common carp (*Cyprinus carpio*) in rice field, in which both the species grew well due to the good abundance of both phytoplankton and zooplankton in this culture system. Another study performed by Ahamed *et al.*[34] who revealed the growth and longevity of this species in a river ecosystem. Another faster growth species silver carp is principally a phytoplankton feeder and known to compete with mola very few cases.

All water quality parameters of the experimental ponds were found to be within the acceptable ranges for aquaculture and there was no abrupt change in any parameters. In the present study the recorded water quality parameters values were varied temperature (14-36°C), transparency (20-40 cm), DO (3.10-8.20 mg $L^{-1}$), pH (6.78-9.10) and alkalinity (52-143 mg $L^{-1}$) those were similar with the previous study[24,25,35-46]. At the beginning of the experiment, temperature increasing and decreased in July due to heavy rain (hence cloudy weather). Again increase in August and decreased trend from late September, on the autumn-winter cooling. The DO and pH increased and decreased more or less similar pattern. Transparency decreased with time, as the organic loading in the ponds due to plankton development, surface runoff during heavy rain, increased fish activity disturbing sediments increased. Alkalinity decreased in July and gradually increased with temperature in September and then to the downward due to winter cooling. Among the five parameters, transparency and DO were not significantly different.

The EST is the higher period (April-December) among the treatments. The ponds of that treatment were re-excavated in some cases and all the ponds were refilled water level upto optimum. Mola bred first time in early culture season, so that mola reproduce early which increased more than the other shorter period of experiment. All of the individual harvesting weights of fishes were high except catla in EST treatment than the SST and EXST treatment. In the treatment covers nearly total culture season of the year. As temperature is very important factor, for every 1°C rise of water temperature the metabolic rate of fish increases 10%, for a 10°C rise of water temperature metabolic rate of fish approximately double[47]. The SGR and survival rate were increased the growth performance SST than the EST treatment. For the short duration preserves the high of that two growth parameters. The SGR values of all fishes in the trial of EST were lower than those reported by Kohinoor *et al.*[48]. Lakshmanan *et al.*[49] revealed a e rate of 80% with seven species composite culture of Indian and Chinese carps, while Wahab *et al.*[50] and Kohinoor *et al.*[48] reported survival rate in poly culture were above 80 and 76-82%, respectively, in similar trials.

Gross production of all carps were measured the following decreasing pattern of silver carp (724.80 kg $ha^{-1}$), mrigal (666.56 kg $ha^{-1}$), rui (584.05 kg $ha^{-1}$), catla (399.03 kg $ha^{-1}$), grass carp (124.38 kg $ha^{-1}$) and bata (93.22 kg $ha^{-1}$), respectively. Between the two longer periods of treatments, the production of three Indian major carps rui, catla and mrigal were 60, 49 and 58% higher in SST than EXST trial. All the breeding frequencies of mola attained in the early stocking ponds, so the highest production of all the treatments. Mola is the highest production (865.46 kg $ha^{-1}$) in early stocking than SST (609.13 kg $ha^{-1}$) and EXST (456.26 kg $ha^{-1}$). The production of all fishes were varied significantly ($p<0.001$) among the treatments. In this treatment, small fish production mola was 23% and other SIS is 8%.

The SST is the shorter period (July-December) of the experiment. All of the carp fishes in that treatment were high value of SGR and survivable than other treatments. Among the treatments the same growth parameters (SGR and Survival) were significantly differences ($p<0.001$). The mrigal is the highest production scorer of all carps. However, the production decreased among the following culture species mrigal (601.49 kg $ha^{-1}$), silver carp (579.50 kg $ha^{-1}$), rui (523.48 kg $ha^{-1}$), catla (377.13 kg $ha^{-1}$), grass carp (865.46 kg $ha^{-1}$) and bata (120.58 kg $ha^{-1}$). All the fish production performed in similar way as used in previous studies[51-55]. Among the two treatments (Existing stocking and seasonal stocking ponds) of the net production of rui, catla, mrigal, silver carp, grass carp, bata and mola is higher 52, 30, 46, 23, 37, 24 and 25% in SST than in EXST. Between the two categories, other SIS (7%) is lower production than mola (19%).

The individual harvesting weights of all carps were higher except catla and very close to rui. The SGR value of catla, grass carp and bata were higher in EXST than EST. Among the treatments, the survival rate of all fishes were low in that and varied significantly ($p<0.001$). Due to the low survival rate the production of total fishes of all carps were low. The net production of three Indian major carps rui, catla and mrigal were lower 35, 23 and 31% than in SST and 41, 34 and 39% in EST, respectively. The lower net production from the SST and EXST was silver carp (19 and 38%) and grass carp (27 and 28%), respectively. The minor carp, bata production was low than other two treatments. Among the all treatments its (EXST) production was comparatively low by carps due to less management of farmers level, but the total small fish production was higher from the other trials. Different the two categories (40%) of small fishes mola covered 16% and other SIS covered 24%. All of the treatments other SIS production was the highest in EXST treatment. It might be the reasons of long culture period which was continued from the previous year.

## CONCLUSION

In the point of biomass, all the carps and mola considered reasonable. On other nutrition point of view, it summarized that introduce mola in polyculture increase the nutritional status of rural households through regular consumption of mola and economic benefits enhanced by mola, other SIS and carps.

## SIGNIFICANCE STATEMENT

This investigation is targeted to enhance the total production in an aquaculture system by combining small indigenous fish (SIS) species with commercial aquaculture species. This study discover the small indigenous fish species can contribute to the total production without affecting the commercial fish production that can be beneficial for small scale aquaculture farmers as well as this extra production of SIS in aquaculture system can provide extra earning with essential micro and macro nutrients to the farmer and end user consumer. This mixed aquaculture system will help to prevent extinction risk of some native and commercially non-important small indigenous fish (SIS) species, which are still under threat of extinction. This study will help the researcher to uncover the critical areas of small indigenous fish (SIS) research that many researchers were not able to explore. Thus a new theory on mixed aquaculture may be arrived at.

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