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Suitability and Production Performance of *Oreochromis niloticus* (GIFT) and *Cyprinus carpio* Under Mono and Mixed Culture System in Coastal Rice Field

¹P.K. Sarker, ²S.U. Ahmed, ²S. Rahman and ³D. Dey

¹Laboratory of Fish Nutrition, Faculty of Agriculture, Kochi University,
Monobe B 200, Nankoku 783-8502, Japan

²Bangladesh Fisheries Research Institute, Brackishwater Station Paikgacha, Khulna-9280, Bangladesh

³Department of Agriculture Chemistry, Faculty of Agriculture,
Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract: Present study deals with the suitability and production potential of two exotic fish species (GIFT: Genetically Improved Farm Tilapia; *O. niloticus*, *C. carpio*) as mono culture and mixed culture system of integrating a short term (mid August-mid December) brackish water aquaculture in the south-west coastal paddy fields of monocropped coastal saline soil at high rain fed region during monsoon season. Twelve paddy plots size ranged from 1320-2080 m² with peripheral trenches (40 cm depth and 45 cm width) and one meter deep ditch in 3% of the area were stocked with fish at a density of 5928 ha⁻¹ for mono and mixed culture (50+50%), after 105 days of rearing average weight and production rate of fish from monoculture of GIFT (T₁), mixed culture of GIFT and *C. carpio* (T₂) and monoculture of *C. carpio* were found 112.5 g, 479.36 kg; (114.2+110.6 g); (241.68+185.21 kg); 114.03 g, 398.95 kg ha⁻¹, respectively. Higher significant production was found in case of GIFT monoculture in T₁ than that of other treatments. Highest net return was obtained from T₁ while lowest net return from rice monoculture crop farming in T₄. So, rice fish farming was economically more rewarding than the rice mono-crop farming. Besides, GIFT monoculture plays a significant production potential for coastal paddy fields.

Key words: Coastal paddy field, GIFT, carpio, production, mono and mixed culture

INTRODUCTION

Southwest coastal area of Bangladesh is mono-cropped in nature, aman rice being the major crop grown during monsoon season. During monsoon season rainwater is accumulated in the fields and allowed to drain-out frequently by the out let. After few such washing operation the soil salinity is generally reduced to a zero ppt. In this situation rice-fish integration could be a very profitable new phenomenon for this region. But the rice farmers of this region were mostly practiced monoculture of aman rice. According to study of Chattopadhyay *et al.*^[1] due to uncertainty in production of monsoon dependent agricultural crops and also prevalence of congenial ecological condition for brackishwater aquaculture, in West Bengal and Kerala to culture euryhaline species of fishes and prawns in the rice fields during the summer fallow period by using highly saline tidal water from the nearby estuary. In southern Bangladesh, farmers allow tidal water to enter fields with local varieties of rice to grow wild fish and shrimp PL till rice is harvested. Average rice production from such

farming has been roughly estimated at 1.8-1.9 t ha⁻¹ and wild fish at some 37.0 kg ha⁻¹^[2]. To become accepted by the farmers rice-fish technology must satisfy farmer's economic settings and productivity of farm environment^[3].

The Brackishwater Station of the Bangladesh Fisheries Research Institute, Paikgacha, Khulna, has, therefore, been investigating rice-fish culture as one farming practice that could possibly improve the sustainability and the circumstances of farmers in south-west Bangladesh. Rahman *et al.*^[4] found that in coastal paddy-fields of Bangladesh with polyculture of exotic fish species performed higher yield and valued technology. Thus the present study investigated the production potential of two exotic fish of GIFT and *Cyprinus carpio* as mono and mixed culture system in coastal paddy field of aman season.

MATERIALS AND METHODS

The study was carried out in aman crop season (mid August-mid December) of 1999, using 12 farmers plots of 1320-2080 m² each, in southeastern coastal region

Table 1: Average growth, survival and production of fish and rice*

Treatments	Stoking rate (No. ha ⁻¹)	Growth				Survival rate	Yield		
		Initial		Final			Fish (kg ha ⁻¹)	Rice (t ha ⁻¹)	
		Length (cm)	Weight (g)	Length (cm)	Weight (g)				
T ₁	5928	9.6	14.4	18.2	112.50	72.20	479.36 ^a	3.80	
T ₂	2964+2964	9.6+12.1	14.4+12.1	18.2+15.7	114.20+110.6	71.40+56.5	241.68+185.21	426.89 ^b	3.70
T ₃	5928	12.1	12.1	14.2	114.03	59.02	398.95 ^b	3.50	
T ₄	-	-	-	-	-	-	-	3.65	

*Mean values within a column with same superscript letter are not significantly different, p<0.05

Table 2: Per hectare costs and return of rice and fish in the rice fish production system

Treatments	Full cost (TK)								
	Human labor	Animal labor	Seedling	Fertilizer					Fingerlings
				Cowdung	Urea	TSP	Zypsum	Zinc	
T ₁	7,500	2,250	787.5	175	173.16	281.15	-	-	5,928
T ₂	7,500	2,250	787.5	500	188.27	262.67	-	24.5	2964+5928
T ₃	7,500	2,250	787.5	-	1086.15	113.75	-	87.5	11,856
T ₄	7,500	2,250	787.5	-	988.00	551.00	122.5	-	-

Table 2: Continued

Treatments	Gross return			Net return			Cost benefit ratio
	Rice	Fish	Total	Rice	Fish	Total	
T ₁	23750.0	23968.0	47718.0	12583.19	18040.0	30623.19 ^a	1:2.79
T ₂	23125.0	12084+7410.5	42619.4	11612.06	10602.5	22214.56 ^b	1:2.09
T ₃	15958.0	15958.0	37833.0	11824.90	4102.0	15926.90 ^b	1:1.60
T ₄	22812.5	0.0	22812.5	10613.50	0.0	10613.50 ^b	1:1.87

*Mean values within a column with same superscript letters are not significantly different, p<0.05

under greater Khulna district. All the plots were under taken for rice-fish research program by Brackishwater Station, BFRI. All the plots were suitably renovated for the purpose of fish culture by constructing peripheral trenches (40 cm depth and 45 cm width), ditch (1 m depth) and dikes. After renovation of all the plots were prepared by Ploughing, leveling and required amount of fertilizer were applied during final plot preparation (Table 2). Seedling of aman rice (variety BR23) was transplanted in all the plots. Transplanting spaces were 20-25cm row to row and 15-20 cm plant to plant and 3-4 seedling per hill.

Fifteen days after paddy transplant, fish fingerlings of GIFT (T₁), GIFT plus *Cyprinus carpio* (T₂) and *C. carpio* (T₃) were stocked with three replication of each treatment at a density of 5928 No. ha⁻¹. At stocking mean weight of GIFT tilapia and *C. carpio* were 14.4 and 12.1 g, respectively. T₄ were exclusively treated as control (alone rice cultivation) with three replication. No pesticides and supplemental feed were used during the culture period. Paddy was harvested in early December 1999 while the fishes were drained into ditch and peripheral canal and finally harvested by middle of December. All the necessary primary data were recorded a fortnightly basis and subjected to analyze with Duncan's Multiple Range Test to determine significant differences between treatment means^[5].

RESULTS AND DISCUSSION

In coastal paddy field consistent evidence of a positive effect of rice-fish on rice production in aman season. In terms of individual survival rate, GIFT is found to show highest survival rate (72.2%) in rice field with GIFT monoculture (T₁), however significant lower survival rate of *C. carpio* (56.5%) was observed in rice field with GIFT mixed culture (T₂) (Table 1). Rahaman *et al.*^[4] reported such lowest survival rate (46.66%) of *C. carpio* in coastal paddy fields. But the present study also revealed that higher stocking density did not exert influence on growth and survivability of these two exotic species in coastal rice fields. Considering growth potential of fish, GIFT shows to do better final weight (114.2 g) in mixed culture system (T₂) than the other two treatments (Table 1). Competition between GIFT and *C. carpio* to occur and resulting in decreased growth of carp^[6]. In this study total yield of GIFT monoculture (T₁), GIFT+ *C. carpio* mixed culture (T₂) and *C. carpio* monoculture in rice field were 479.36 kg ha⁻¹, 241.68+185.21 kg ha⁻¹, 398.95 kg ha⁻¹. Das and Dewan^[7] reported on yield of 120.0 and 90.0 kg ha⁻¹ by stocking *Oreochromis mossambicus* and *C. carpio*, respectively for a period of 2.5 months. Integrating pisciculture with rice cultivation in high rain-fed coastal saline areas, on an

average, 1030.3 kg ha⁻¹ fishes and prawns were obtained in addition to normal yield of rice. Of the additional production, 530.5 kg ha⁻¹ were obtained through brackishwater aquaculture during the summer season when the lands would have otherwise remained fallow and also accumulated salts from gradual evaporation of lightly saline ground water^[8].

As is evident (Table 1) per hectare yield of rice in fish farming of T₁, T₂ and T₃ were 3.80, 3.70 and 3.50 t ha⁻¹, respectively while the yield (3.65 t ha⁻¹) obtained from rice mono-crop farming (T₄). Hora^[9] observed that the yield of rice increased by approximately 15.00% in Indo-Pacific countries due to adoption of fish culture.

A detail cost analysis of four treatments (Table 2) indicate among all the cost items human labor (Tk.7,500), animal labor (Tk.2,250), seedling costs (Tk.787.5) are same for all the treatments. Fertilizer and fingerlings costs are variable. Because according to the nature of soil of paddy fields required type and amount of fertilizer were used. Fingerling price was not same for two species. Per hectare cost of producing rice and fish together were estimated at Tk. 17,094.81, 20,404.94 and 23,880.90 for T₁, T₂ and T₃. As a single enterprise of aman (T₄) producing cost was estimated at Tk.12,199.0

The estimated overall gross return from rice-fish farming with T₁, T₂ and T₃ were Tk 4,7718.0 ha⁻¹, 4,2619.40 ha⁻¹ and 37,833.0 ha⁻¹, respectively. Gross return obtained from rice-monoculture was Tk. 22, 812.50 ha⁻¹ (T₄) (Table 2). Per hectare overall net return in rice-fish farming was Tk. 30,623.19; 22,214.56; 15,926 for T₁, T₂ and T₃ while net return in rice-mono crop (T₄) farming stood Tk. 10,613.50. It should be mentioned that the overall net return per hectare from rice-fish farming of GIFT mono culture (T₁) was significantly higher than the net return earned from *C. carpio* mono culture (T₃) and GIFT-*Cyprinus carpio* mixed culture (T₂) while the rice mono-crop farming (T₄) showed the lowest net return. Rice-fish farming could give an additional income of 4-21%, with an average of 13.5% without affecting the rice production^[10]. In this study except the cost-benefit ratio of T₃ (1.6) in all the treatments with rice-fish farming relatively higher (T₁=2.79; T₂=2.09) than in rice-mono crop farming (T₄=1.87)

The result of the present study demonstrates that rice fish culture in coastal paddy-field was found more profitable than rice-monoculture and based on growth performance and net return, mono and mixed culture of GIFT in coastal paddy-field indicate the very promising species of integration. Moreover, in terms of fry and fingerling production, GIFT tilapia truly surprisingly, has the greatest potentialities. According to David *et al.*^[11] large quantity of tilapia (*Oreochromis niloticus*) seed

were produced in the rice field of southwest Bangkok where water depths were 40-60 cm. That's why self-sufficiency in seed fish by farmers could probably positive impact on fish culture and rice fish culture system as well. However, natural reproduction by common carp was not so significant during this study period.

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