http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (4): 610-612, 2000

Study on the Suitability of Culture of Exotic Fish Species in the Coastal Paddy Fields of Bangladesh under Mono and Mixed Culture System

S. Rahman, P.K. Sarker, S.U. Ahmed, M. Rafiquzzaman[1] and S.M. Ferdous[1]
Brackishwater Station, Bangladesh Fisheries Research Institute Paikgacha, Khulna-9280
[1]Department of Agriculture Extension, Paikgacha, Khulna-9280 Bangladesh

Abstract: A study was carried out during the Aman season (September-Dcember) in the south-west coastal paddy fields of Bangladesh to understand the culture suitability and production potential of two exotic fish species, namely *Puntius gonionotus* and *Cyprinus carpio* in rice fish integrated culture system. Twelve paddy plots with size ranges from 1300-27000m^2 were stocked with fish at a density of 4930 /ha for mono & mixed culture (50+50%). After 50 days of rearing production rate of fish from monoculture of *Puntius gonionotus* (T_1), mixed culture of *Puntius gonionotus* and *Cyprinus carpio* (T_2) and monculture culture of *Cyprinus carpio* (T_3) was found 280.12, 330.40 (119.64+210.76 kg) and 279.78 kg ha^{-1}, respectively. No significant variation in fish production was observed between T_1 and T_3. But compare to other treatments significant higher production of fish was obtained from T_2. However, for rice production a significant lower production (3.14 ton h^{-1}) was obtained for T_3 compare to other two treatments, while higher rate of rice production (3.85ton/h) was recorded for T_1. For control plot (T_4) the production rate of rice was 3.40 ton h^{-1}. In the study, no negative correlation was found for the integration of fish with rice culture.

Key words: Coastal, exotic, paddy field, rice, fish production.

Introduction

The integrated culture of rice and fish has been practicing for the last hundred of years in a very traditional way in Bangladesh and which has been recently shown more interest for the development of low cost production technologies. Recent investigations in this respect has indicated that integrated rice-fish systems offer possibilities of increasing rice yields by as much as 15% and at the same time fish harvesting up to 500 kg/ha/crop (Lightfoot *et al.*, 1989). Recently rice fish culture farming techniques has been emphasized not only for potentially increase of yield farm income and national fish out put but also as a means to keep the culture environment friendly. This is also to compensate the economic losses in rice production brought about by natural calamities. On the other hand it could generate employment, increase farmers income and help to alleviate malnutrition by providing additional source of animal protein (Roy *et al.*, 1990)

Studies have indicated that the total area of rice fields in Bangladesh is about 10.14 million ha which can play a significant role by increasing additional fish production (Rahman, 1995). The field modified for rice-fish culture normally requires few changes with good water holding quality to assure adequate fish production. A number of South Asian rice producing countries like Philippine, Thailand, Malaysia, Laos, Vietnam, India having region wise good soil facilities for rice production has been incorporating the system of integrated rice-fish production by introducing various quick growing local and exotic fish species. The experience from the success history of the region explains the positive impact of such approaches. But the selectivity criteria of species should be considered by quality of the species itself, its growing nature, feeding habit, soil condition and water depth of ditch and quality of specific rice plot. Though rice-fish farming is an ancient practice in Asia (Mackay *et al.*, 1987; Li and Pan, 1991) but details study to investigate its feasibility and comparative productivity is still in its initial stage. So to find out suitable fish species and their production potential for culture in the coastal paddy fields of Bangladesh, two exotic fish species where considered under mono and mixed culture systems under Amon crop.

Materials and Methods

The experiment was conducted during Aman crop season (September to December) of 1998, using 12 farmers plots of different size ranges from 1336-2672 m^2 in different villages of south western coastal union=s namely Raruly, Sreerampur, Horidhali and Kapilmuni under Paikgacha thana of Khulna district. Each of the plots (except T_4 plot) were excavated up to one meter depth, covering 3% area of the total plot in the low-lying side and a peripheral trenches having 40 cm depth and 45 cm width surrounding the field to provide shelter for the fish during low water levels and high temperature. The removed soil was used to heighten the dikes. All the plots were prepared by ploughing, leveling and proper fertilization depending upon the soil nature of the plot (Table 3). Then the seedling of Aman (varity BR 23) were transplanted in all the plots following double line spacing suitable for fish movement.

After fifteen days of transplanting fingerlings of *P. gonionotus* (T_1), *P. gonionotus* and *Cyprinus carpio* (T_2) and *Cyprinus carpio* (T_3) were stocked with three replication of each treatment in the rice fields at a density of 4930 kg ha^{-1}. At stocking the average weight of *P. gonionotus, C. carpio* was 10.5 and 13.95 g, respectively. During fish release the water depth of the rice field was mainiained at least about 18-20 cm which further increased gradually. Besides, T_4 were exclusively treated as control (only with rice cultivation) with three replication.

In course of study period the physico-chemical parameters like water temperature, dissolved oxygen, water depth, pH, alkalinity and hardness were monitored fortnightly. In the southern region, as water starts receding from the middle or end of November so fish was harvested when the water depth in ditches become too low for the fish to survive and rice was harvested by the middle of December.

Analysis of variance (ANOVA) and Duncan's New Multiple Range Test was carried out to find out any significant variation in production of rice and fish among the treatments (Gomez and Gomez, 1984)

Results and Discussion

Water quality parameters of the plots recorded during the study period are shown in Table 1. As evidence from the table the mean water temperature were found 31.72, 29.90 and 30.32°C for T_1, T_2 and T_3 respectively. Islam *et al.* (1998) also observed almost similar range of temperature (26.1- 32.2°C) in rice fish culture during Amon crop which had been considered as suitable for fish culture. The recommended range of temperature for fish and crustacean culture was also described by Chin (1988) and Nakara (1994) as 25-31°C. So the temperature range recorded can be considered suitable for fish culture.

Table 1: Average values of water quality parameters of rice-fish plots during the study period.

Parameters	Treatments			
	T_1	T_2	T_3	T_4
Water temp. (0°C)	31.72	29.90	30.32	-
Water depth (cm)				
Rice Field	17.96	19.15	19.18	-
Ditch	96.74	75.66	90.71	-
Canal	40.21	43.28	38.97	-
DO (ppm)	5.80	5.3	5.9	-
pH	7.64	7.72	7.88	-
Alkalinity (mg/L)	183.00	175.80	124.25	-
Hardness (mg/L)	189.37	172.12	179.66	-

Table 3: Average value of soil quality parameters of the ponds and application of fertilizer based on the soil quality.

Soil quality parameter	T_1	T_2	T_3
pH	8.1	7.53	8.03
Conductivity (Decisiemen/m)	3.24	9.45	5.38
Organic matter (%)	2.65	2.75	2.24
Sodium (M.eq./100g)	3.46	4.16	3.33
Calcium (M.eq./100g)	23.66	17.83	18.25
Magnesium (M.eq./100g)	3.25	4.83	3.50
Potassium (M.eq./100g)	0.56	0.87	0.83
Total nitrogen (%)	0.137	0.130	0.107
Phosphorus (µg/g)	23.44	36.36	37.89
Sulfur (µg/g)	19.72	22.98	20.33
Boron (µg/g)	1.01	1.05	0.42
Copper (µg/g)	3.37	6.58	4.64
Iron (µg/g)	37.03	77.90	54.86
Manganese (µg/g)	7.07	12.08	8.33
Zinc (µg/g)	0.402	1.16	0.52
Fertilizer	T_1 kg/h	T_2 kg/h	T_3 kg/h
Urea	106.0	167.1	184.0
TS.P	3.35	-	-
Gypsum	40.5	32.5	39.0
Zinc	8.25	1.25	8.0

Average dissolved oxygen content for T_1, T_2 and T_3 were determined 5.8, 5.3 and 5.9 ppm respectively. Chattopadhyay *et al.* (1987) recorded dissolved oxygen ranges from 4.8 to 8.8 ppm in rice-cum-fish culture plot which is almost similar to the present study. Yung (1990) described the DO content of water for fish culture should range from 5.0-7.5 ppm which is in agreement with the present finding. Mean value of pH in T_1, T_2 and T_3 were found 7.64, 7.72 and 7.88 which is within the range described by Miah *et al.* (1994) and Ghosh (1992) in rice fish farm. Alkalinity was found as 183, 175.8 and 124.25 ppm for treatment T_1, T_2

Table 2: Average growth, survival and production of fish and ric[e] and cost benefit ratio of the products.

	Treatment			
	T_1	T_2	T_3	T_4
Stocking rate (No./ha)	49.30	2465 ± 2465	4930	-
Growth Initial				
Length (cm)	9.46	9.46 ± 11.57	11.57	-
Weight (cm)	10.5	10.5 ± 13.95	13.95	-
Growth final				
Length (cm)	17.5.	15.38 ± 17.77	18.78	-
Weight (cm)	78.67	67.67 ± 127.28	121.60	-
Survival rate (%)	72.22	71.72 ± 67.17	46.66	-
Yield				
Fish (kg ha^{-1})	280.12[a]	119.64 ± 210.76[b]	279.78[a]	-
Rice (t ha^{-1})	3.85[a]	3.99[a]	3.14[b]	3.40
Production cost (Tk ha^{-1})				
Rice	8425.00	8233	8864	900
Fish	4930.00	6162	7395	
Total	13355.00	14395	16241	900
Gross Return				
Rice	25988.00	26933	21195	229
Fish	16407.00	18172	15388	0
Total	41395.00	45105	36583	229
Net Return				
Rice	17563.00	18700	12349	133
Fish	10477.00	12010	7993	0
Total	28040.00	30710	20342	139
Cost Beneefit Ratio	1:3.09.	1:3.13	1:2.25	1:2.

and T_3 respectively. Almost similar findings was obtained [b]y Chattopadhyay *et al.* (1987) in rice-fish field. Rahman (199[.]) noted that total hardness might vary from 0.0 to several hundr[ed] ppm. However, in this study the mean value of hardness in T_1, [T_2] and T_3 was found 189.37, 172.12 and 179.66 ppm respective[ly] which might due to the farm location and application [of] carbonated lime. As the coastal paddy fields mostly flushed [by] coastal saline water at least one part of the year, so deposition [of] calcium and magnesium carbonate and bicarbonate in the soil fr[om] saline water may occur and can increases the soil alkalinity t[o] greater extent.

Initial and final length-weight (growth performance) survival a[nd] production of fish and rice and cost benefit ratio are shown [in] Table 2. Data reveals an average highest survival for *P. gonionot[us]* in T_1. However significant lower survival (46.66%) for *C. car[pio]* was observed in T_3. Survival of *P. gonionotus* in T_1 & T_2 w[ere] 72.22 and 71.72% respectively.

In this study *P. gonionotus* attained average better final wei[ght] and offered higher total fish yield and earning net return wh[ich] were 78.67g, 280.12 kg ha^{-1} and 10,477 TK. ha^{-1}, respectiv[ely] (Table 2). Kohinoor *et al.* (1995) reported the range of aver[age] weight, yield and net income were 50.3-99.7gm, 58.0-10[.] kg ha^{-1} and 850 -2,979 Tk ha^{-1} for *P. gonionotus* in rice-f[ish] integrated culture. But for better production Ali *et al.* (19[..]) identified that the *Azolla pinnata* (kutipana) as a promising feed [for] *P. goinotus* and recorded that the production under mono cul[ture] in rice fish with a stocking density of 1/m^3 was 3.00 t ha^{-1} [,] recovery percentage and average weight was 76 and 20[.] respectively.

For mixed species (T_2) the performance was also encouraging. The mean weight gain by *C. carpio* was found higher (127.28g) followed by *P. gonionotus* (67.67). Similarly, a total yield of 210.76 kg ha^{-1} and 119.64 kg ha^{-1} for *C. carpio* and *P. gonionotus*, respectively was obtained. Rahman (1995) reported a higher total yield of 325-375 kg ha^{-1} from the mixed culture of *P. gonionotus* and *C. carpio*. However the average individual weight of the species was recorded as 100-120 and 250-400g for *P. gonionotus* and *C. carpio*, respectively.

For monoculture of *C.carpio* (T_3) average weight, survival rate, yield and net income was 121.60g, 46.66%, 279.78 kg ha^{-1} and Tk 7993 Tk. ha^{-1} respectively. In a similar kind of work Akhteruzzaman *et al.* (1993) recorded an average weight and yield of *C. carpio* as 600g and 147.5-222.5 kg ha^{-1} respestively where though the individual weight gain was maximum but the survival was less. In spite of having a faster growing tendency of *C. carpio* then *P. gonionotus*, the production rate of these species from T_1&T_2 was almost equal which was due to the high mortality of *C. carpio* in turbid water and presence of Azolla (*Azolla pinnata*) in T_1 plots as feed for *P. gonionotus*. Because of difference in dwelling nature and feeding habit of the species while mixed cultured, offered a significant higher production than the other two treatments.

The mean production of rice was 3.85, 3.99, 3.14 and 3.40 t/ha for T_1, T_2, T_3 and T_4 respectively (Table 2). Islam *et al.* (1998) recorded the average rice production from rice-fish farming during Aman season as 3.83 to 4.29 t ha^{-1} which is almost similar to the present findings. Better production of rice in T_2 might due to the fact that the soil type of the plot was sandy loamy and was rich in soil nutrients like organic matter, total nitrogen, zinc, potassium, magnesium and phosphorus etc. (Table 3). Among the rice-fish plots, better production, appreciable cost benefit ratio and net return per hectare were found in T_2 followed by T_1 & T_3. The cost benefit ratio of rice-fish showed least in T_3 due to the low production of rice as well as low survival rate of fish. Actually cost-benefit ratio also rely on soil fertility because to intensify the production of soil more fertilizer is required and ultimately increase the production cost. As evidence from Table 3 the maximum requirement of fertilizer were in T_4 followed by T_3, T_1 and T_2. Fish yield in T_3 were more or less similar with T_1 because of individual weight gain by *cyprinus carpio* was higher (121.60g) than that of *P. goniorotus* (78.67g). On the other hand cost benefit ratio of T_4 (only rice) apparently showed higher than T_3 but the net return of T_3 was higher (20342/ha) than T_4 (13950Tk/ha). This higher net return from riceBfish production system is mainly due to the contribution of fish yield.

However, the present study has demonstrated that integrated rice-fish farming with polyculture of *P. goniorotus* and *C. carpio* resulted in a higher yield and cost effective and valued technology for the rice farmer of Bangladesh as well as for other areas with similar geographical and environmental condition.

References

Akhteruzzaman M., M. V. Gupta, I.D. Sollows and H.M. koninoor, 1993. Feasibility of integrated aquaculture in rain fed rice fields and possible implications for integratedpest managementin Bangladesh. In: Role of fishin enhancing rice fields ecology and in integrated pest management (ed. C.R. Delta. Cruz). ICLARM Conf. Proc., 43: pp: 50.

Ali, M.H., N.I. Miah and N.U. Ahmed, 1993. Experience in deepwater rice fish culture. Bangladesh Rice Research Institute Dhaka, pp: 16

Chattopadhyay, G. N., C.R. Biswas, A. Ghosh, P.K. Chakraborti, and A.K. Bandopadhyay, 1987. A study on rice-fish culture in coastal saline soils. J. Indian. Soc. Coastal Agric. Res., 5: 245-249, 1987.

Chin, Y. N., 1988. Consideration for planning prawn farm pprojects. In: Technical consideration for the management and operation of intensive prawn farms. Y. N. Chin. L. M. Santos and R. O. Julinao eds. U.P. AquacultureSociety, Iloilo City. Philippines, pp: 25-28.

Ghosh, A., 1992. Rice-fish farming development in India: Past, present and future. In: Rice-fish research and development in Asia. (eds. C. R. Dela cruz, C. Lightfoot, B.A. Costa - pierce, V. R. Carangal and M. P. Bimbao). ICLARM Conf. Prov. 24: 27-41.

Gomez, K.A. and A.A. Gomez, 1984. Three of more factors experiement: In: Statistical procedure for Agricultural Research. A Willy Interscience Publication, pp: 130-240.

Kohinoor, A. H. M., S. B. Shah, M. Akhteruzzaman and M. V. Gupta, 1995. Suitability ofshort cycle species Puntius gonionotus (bleeker) forculturein rice fields. J. Inland Fish. Soc. India, 27: 1995: 60-64.

Li, K. and Y. Pan, 1991. Rice fields as nurseriesand fish grow-out systems under rice-fish farming systems. Ibid.

Lightfoot, C., Dam. A. Van and B. Costa-Pierce, 1989. What is happening tothe rice yields in rice-fish systems. In: C. Cruz, C. Light foot, B. A. Cost-Pierce and V. R., Carngal (edc). Rice-Fish research and development in Asia, ICLARM conf. Proc., 24 (in press)

Mackay, K., T.G. Chapman, J. Sollows and J. Thongpan, 1987. Rice-fish culturein north-east Thailand: Stability and sustainability. In: P. Allen and D. Van Dusen (eds). Global perspective on agroecology and sustainable agricultural systems. Proc. 6th intp. Fed. Organic Agril. Movements, University of California, Santi Cruz, USA, 355-372.

Miah, M. N. I., M. H. Ali and N. U. Ahmed, 1994. Mono and plyculture of silver bard (*Puntius gonionotus*) in deepwater rice systemsin Bangladesh. NAGA, the ICLARM quarterly. Vol. 17: 26-27.

Nakra, M. 1994. Prawn farming manual. Waterda Ltd. Anantha puram, Nellore-52344, India, pp: 113.

Rahman, A. A., 1995. Rice-cum-fish farming. Fisheries Development Technologies. A fish forthight compendium. 1995. Fisheries Research Institute, Mymensigh, Bangladesh, 44-45.

Rahman, M. S., 1992. Water quality management in aquaculture. BRAC Prokashana. 66 Mokhakhali, Dhaka-1212 Bangladesh, 27.

Roy. B. and D. N. Das and P. K. Muhopadhyay, 1990. Rice-fish-vegetale integrated farming: Towards a sustainable ecosystem. NAGA, the ICLARM Quarterly, 13: 17-18.

Yung, C. H., 1990. Effect of some environmental factors on the growth of Chinese shrimp, P. Chinensis. In: The culture of cold tolerant shrimp Proceedings ofAsian U.S. workshop on shrimp culture. K. L. Main and W. Fulks eds. The Oceanic Institute, Honolula, HI., pp: 92-101.