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M.S. Parvez[1], M. Salekuzzaman[2], M. E. Hossain[3], K. Azam[4]

[1]Research Assistant (M&E), G5 Project, The WorldFish Center, , Khulna, Bangladesh; [2]Professor, Environmental Science Discipline, Khulna University, Khulna, Bangladesh; [3]M&E Specialist, G5 Project, The WorldFish Center, Bangladesh and South Asia Office, Dhaka, Bangladesh; [4]Professor, FMRT Discipline, Khulna University, Bangladesh

(BANGLADESH)

E-mail: M.Parvez@cgiar.org

ABSTRACT

The research focus on the gher farming systems in southwest part of Bangladesh and which system is more beneficial in economically through yielding rice or prawn or in combination – it is only rice or only gher or the combination of both. The experiment was done with freshwater prawn (*Macrobrachium rosenbergi*) and rice in order to analysis whether rice farming has any effect on the growth of prawn or conversely whether prawn farming has any influence on rice production. The study was carried out for a period of 112 days with two replications for each treatment. The result suggested that the yield of prawn could be increased by 18% if prawns are cultivated along with rice and would not hamper rice production significantly ($p>0.05$). The study was also indicated that approximately 19 % higher benefit- cost ratio could be obtained by employing this method. The total economic productivity analysis of benefit cost ratio was higher obtained from 2.87 compared to 2.42.

Key Words: Freshwater Prawn, Rice, Gher, Economic

1. INTRODUCTION

Most the gher farmers in Khulna, Satkhira and Bagherhat districts do not grow rice along side prawns in the rainy season. The farmers claim that prawn productions decline if they cultivate rice in the ghers. They believe that the quality of water in the ghers deteriorates after the decomposition of rice, straw and leaves and the grazing areas of the prawns also reduce due to rice cultivation. Prawns may be trapped sometimes among the rice plants (the rostrum of the prawns enter into the rice plants, immobilizing them and eventually causing death) yielding in a further fall in production. These farmers' believe that there were however not yet tested or proven, and therefore this experiment was conducted with the intention of assessing prawn yields in relation to rice farming and vice-versa, as well as to study the economics of new technical options than the general practice (Parvez[b].2006).

Freshwater Prawn culture is a common practice in southwestern part of Bangladesh. Many farmers of this region (mainly cultured in Bagherhat district of Bangladesh) are culturing this practice in gher farming system with the support of National and International Organization. The Department of Fisheries (DoF) is also providing technical support to the farmers. Moreover, DoF people sometimes visiting their fields as well as giving suggestions for better production of prawn but not advice cropping yields that is support in economically viable. But the productivity of rice cum freshwater prawn in gher farming way, the farmers are able to reach their targets in terms of production as well as financial benefit.

2. MATERIALS AND METHODS

The study was carried out at the farm of Amirul Islam Gazirhat, Debhata, Satkhira from 10th August 1999 to 2nd December 1999 a period for 112 days. The experimental design is shown in Table 1. To assess the effect of rice on prawn yield, the control (C_1) was without rice (only prawn) and the treatment was rice + prawn (C_2). To test the effect of prawn farming on rice yield the control (C_3) was without prawn (only rice) and the treatment was rice + prawn (C_2).

Table 1. Experimental Design

Treatment	Replication
C_1	2
C_2	2
C_3	2
Total	6

C_1 = Only Prawn; C_2 = Prawn + Rice; C_3 = Only rice

Six ghers with Chatal (Rice field) areas of 52 m^2, were constructed side by side and L-shaped trench was constructed at the periphery of chatal of each gher with same area. The Chatals of C_1 and C_2 were surrounded with bamboo fences to prevent prawns from escaping, and approximately 20% of the Chatal areas of all the ghers were shaded with coconut & plum leaf to protect the prawns from the excess sun heat. The chatal of each gher was leveled and ploughed. Liming was done at the ration of 1 Kg per decimal and distributed properly. After 5 days of liming, fertilization was done to the experimental plots and thoroughly mixed in with the soil at the ration cow dung 4 Kg/dec, urea 100 gm/dec, and TSP 50 gm/dec respectively. A local variety of Aus rice seedlings were used in the gher. The seedlings were transplanted to the chatal of the experimental plots for 35 days old plantation. Line to line and plant-to-plant spacing was maintained at 35 cm and 20 cm respectively and 2-3 seedlings were used for each hill. No additional fertilizer were used for rice cultivation. The rice was harvested on 31st September 1999.

The prawns were purchased wild post larvae from local trades and had reared them in their own reared tanks. The prawns were stocked on the 10th August 1999 and harvested on the 2nd December 1999. A commercial feed pellets, Saudi Bangla Prawn Feeds applied. The prawns in C_1 and C_2 treatments were fed at 4%-5% of their total body weight. They were fed twice in a day i.e. once in the morning at 6.30 a.m. (1/3 of the daily ration) and in the evening at 5.00 p.m (2/3 of the daily ration). The feed was placed on two earthen trays on the bottom of the Chatal. The feed sample was analyzed at Khulna University and proximate composition of this feed was moisture 11.9%, crude protein 26.8%, lipid 7.4% ash 12.2%, crude fiber 7.2% and nitrogen free extract 34.46% respectively. After stocking, all plots were regularly fertilized to maintain the water's green colorations throughout the experiment. The same fertilizers were applied at the following rates e.g. cow dung 500g/dec/week, urea 70 gm/dec/week and TSP 40 gm/dec/week. Before stocking and harvesting, 13 prawns of each gher randomly and individually weighed in a digital balance while all the prawns were also weighed in bulk. The 13 prawns were measure to the nearest millimeter, and their average length and weight calculated. Water was supplied to the ghers by shallow pump when the water level was dropped and always maintained at 40 cm to 50 cm of the chatal's height during the experimental period. Dissolved Oxygen was measured every fortnight at 7 am and again at 4 pm. P^H value was also recorded at the same times respectively. Temperatures were also recorded fortnightly with a thermometer at the same time. Ammonia was recorded at 8am fortnightly. All parameters for monitoring the water quality were measured using the HACH test Kit (model FF1A). The data was calculating and analyzing.

The cost of leasing a gher was estimated based on discussions with farmers and staff, instead of using the construction. The actual prices of all materials were used to accurately work out the economics of the experiment. The costs of day-to-day tasks like feeding and cleaning were not included in the economic calculation. These inputs were written off as opportunity costs. The yield, recovery rate, food conversion ration, specific growth rate and cost-benefit ratio were all calculated using the following formulae;

$$\text{Yield} = \text{Biomass at harvesting} - \text{Biomass at Stocking}$$

$$\text{Recovery rate (\%)} = \frac{\text{Harvest numbers}}{\text{Stock Numbers}} \times 100$$

$$\text{(FCR) Food Conversion Ratio (gm)} = \frac{\text{Feed given}}{\text{Weight gain}}$$

$$\text{Specific Growth Rate (\%)} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Duration (days)}} \times 100$$

$$\text{Cost-benefit ratio} = \frac{\text{Total income}}{\text{Total cost}}$$

Nitrogen free extract = 100% - (moisture % + protein % + lipid % + ash % + crude fiber %)

Statistically analysis “t”- Test was performed on the prawn yield and the SGR of control C_1 and treatment (C_2). “t”-Test was also performed on the rice yield of the control and treatment.

3. RESULTS

Effect of rice farming on prawn growth

Table 2. shows that the mean higher yield of prawn was obtained from treatment (C_2, rice + prawn, 2.04 kg/dec compared to the control (C_1, only prawn, 1.72 kg/dec). “t”-Test indicated significant differences ($p<0.05$) in yield between the control (C_1) and the treatment (C_2). The mean SGR (Specific Growth Rate) was recorded significantly higher ($p<0.05$) in treatment (prawn + rice, 2.31%) than control (only prawn, 2.25%). Better (lower) FCR (Food Conversion Ratio) was obtained from C_2 (1.3) compared to C_1 (1.8). And Table 3. shows that higher recovery rate was obtained in C_2 (94%) compared with C_1 (84%). Economic analysis showed that higher benefit cost ratio was obtained from C_2 (2.86) compared to C_1 (2.42).

Table 02. Details Prawn Stocking and Productivity of the experiment

Stocking & Productivity Parameter	**C_1 (Control, only prawn)**	**C_2 (Treatment, Prawn + rice)**
Average weight (gm)	7.9	7.6
Biomass (Kg/dec)	0.32	0.31
Number/Plot	52	52
Number/Dec	40	40
Harvesting		
Average weight (gm)	60.4	61.2
Gross production (Kg/Dec)	2.0	2.3
Yield (Kg/Dec)	1.72^a	2.04^b
Crude FCR	1.8	1.3
Recovery rate (%)	83.7	94.2
SGR (%)	2.25^a	2.31^b

Note: Superscripted different letters in a row are significantly different at p<0.05

Table 3. Economics of Prawn Farming

Economic factors	**C_1 (Control, only prawn)**	**C_2 (Treatment, Prawn + rice)**
Gher leasing cost (Tk/dec/cycle)	23.7	23.7
Liming Cost (Tk/dec)	5.0	5.0
Fertilization cost (Tk/dec)	17.4	17.4
Seed cost (Tk/dec)	204.0	204.0
Feed Cost (Tk/dec)	63.1	53.6
Sub-total cost for prawn (Tk/dec)	313.2	303.7
Total prawn sale (Tk/dec)	756.9	868.4
Net profit (Tk/dec) from prawn	443.7	564.7
Benefit cost ratio for prawn cultivation	2.42	2.86

Table 4. Rice production of the experiment in details

Rice Production Parameter	**C_1 (Control, only prawn)**	**C_2 (Treatment, Prawn + rice)**
Rice yield (Kg/dec)	-	4.07
Straw yield (kg/dec)	-	6.03
Number of Tiller/hill	-	9
Plant population (hill number/m^2)	-	14.0

Table 5. Economic Factors of Rice Farming

Economic Factors	**C_1 (Control, only prawn)**	**C_2 (Treatment, Prawn + rice)**
Ploughing cost (Tk/dec)	-	5.5
Seedling Cost for rice (Tk/dec)	-	5.0
Sub total cost for rice (Tk/dec)		10.5
Rice sale (Tk/dec)	-	28.5
Straw Sale (Tk/dec)	-	6.0
Sub-total sale for rice (Tk/dec)	-	34.5
Net profit from rice (Tk/dec)	-	24.0
Cost benefit ratio for rice farming	-	3.29

Table 6. Total productivity of the experiment in details

Productivity items	**C_1 (Control, only prawn)**	**C_2 (Treatment, Prawn + rice)**
Total cost (Tk/dec)	313.2	314.2
Total Sale (Tk/dec)	756.9	902.9
Total net profit (Tk/dec)	443.7	588.7
Benefit cost ratio	2.42	2.87

Table 6. shows that total productivity analysis of benefit cost ratio was higher obtained from C_2 (2.87) compared to C_1 (2.42). Table 07 shows that the mean DO was recorded a little higher in C_1 followed by C_3 and then C_2, both in morning and afternoon. On the other hand the Table 8., The p^H value of the treatments was also found to be a little higher in C_1, followed by C_3 and C_2 (both in morning and afternoon). Temperature was recorded at about 28^0C in the morning and about 30.5^0C in the afternoon (Table 9). The mean ammonia content was found to range between 0.0016 mg/l to 0.0026 mg/l during the course of the experiment (Table 10).

Table 7. Oxygen as a water quality parameter of the experimental plots

		C1 (Only prawn)		C2 (Prawn + Rice)		C3 (Only rice)	
		R_1	R_2	R_1	R_2	R_1	R_2
Oxygen	At 7 am (mg/l)	4.40	4.50	3.90	3.80	4.10	4.00
	Sd (±)	0.13	0.19	0.16	0.19	0.21	0.29
	At 4 pm (mg/l)	7.50	7.60	6.70	6.70	7.10	7.20
	Sd (±)	0.35	0.17	0.14	0.13	0.22	0.10

Table 8. p^H as a water quality parameter of the experimental plots

		C1 (Only prawn)		C2 (Prawn + Rice)		C3 (Only rice)	
		R_1	R_2	R_1	R_2	R_1	R_2
p^H	At 7 am	7.80	7.70	7.10	7.30	7.50	7.40
	Sd (±)	0.20	0.40	0.40	0.50	0.70	0.90
	At 4 pm	8.10	7.80	7.30	7.40	7.80	7.60
	Sd (±)	0.30	0.40	0.40	0.40	0.60	0.40

Source: Field

Table 9. Temperature as a water quality parameter of the experimental plots

		C1 (Only prawn)		C2 (Prawn + Rice)		C3 (Only rice)	
		R_1	R_2	R_1	R_2	R_1	R_2
Temperature	At 7 am (0^0C)	28.10	28.00	27.8	27.70	27.80	28.00
	Sd (±)	0.50	0.70	0.60	0.70	0.90	0.80
	At 4 pm (0^0C)	31.00	31.00	30.5	30.60	30.40	30.60
	Sd (±)	1.20	1.00	1.20	1.10	1.30	1.40

Source: Field

Table 10. Ammonia as a water quality parameter of the experimental plots

		C1 (Only prawn)		C2 (Prawn + Rice)		C3 (Only rice)	
		R_1	R_2	R_1	R_2	R_1	R_2
Ammonia	(mg/l)	0.0018	0.0016	0.0026	0.0026	0.0021	0.0024
	Sd (±)	0.0004	0.0009	0.0015	0.0011	0.0005	0.0018

Source: Field

Effect of Prawn cultivation on rice yield

Table 11. shows that results of the effect of farming prawns on rice yield. No significant difference ($p>0.05$) in the rice yield was found between the control (C_3, only rice) and the treatment (C_2, prawn + rice).

Table 11. Comparison of rice production in two different culture systems

	C_3 (Control, only rice)	C_2 (Treatment, prawn + rice)
Plant population (hill number/m^2)	14.3	14.0
Tillers (number/hill)	9.75	9.0
Grain yield (Kg/hector)	1115.5^a	1005^a
Straw yield (Kg/hector)	1653.5	1488.5

Source: Field ; Note: Superscripted same letter in a row is not significantly different (p> 0.05).

4. DISCUSSION

Effect of rice farming on prawn

The mean highest yield of prawn was obtained from C_2 (rice + prawn, 2.04 Kg/dec) compared to the C_1 (control, only prawn, 1.72 Kg/dec). This means that prawn yields can be increased by 18.33% if the prawns are cultivated along with rice. The reason for higher yield was higher recovery rate for the control. "t"-Test indicated a significant difference ($p<0.05$) in the yield between C_1 (control) and C_2 (treatment). Nguyen *et.al*. (1993) noted that the gross production of *Macrobrachium rosenbergii* fed on fruit leaves and vegetables from one annual crop with a rice production of 8.5 ton/ha (from two crops) at 1.43 kg/dec in Vietnam where rice cultivation gained more emphasis than the prawn farming (Phuong, *et.al.* 2006). The means that SGR was recorded almost similar for both the C_1 (control, 2.25%) and C_2 (treatment, 2.31%). However, "t"-Test indicated a significant difference ($p<0.05$) in SGR between C_1 (control) and C_2 (treatment). Generally, good FCR was gained from both the treatment (C_2) and control (C_1). Reasons might include the utilization of natural foods by prawn, which were produced through regular fertilization. However, better (lower) FCR obtained from C_2 (1.3) compared to C_1 (1.8). Another reason might be the use of insects and their larvae as food by prawns in the rice field (C_2). Moreover, prawns might eat periphytons that grow on rice plants. Higher recovery rate was obtained in C_2 (94%) compared with C_1 (84%). The reason might less cannibalistic character found in C_2 as rice plants created more enable shelter for prawns during moulting. These findings conflicted with farmers' opinion.

The economic analysis shows that higher benefit-cost ratio was obtained from C_2 (2.87) compared to C_1 (2.42). The results of the present investigation indicated that 18.6% higher benefit cost ratio could be obtained if the Aus rice is cultivated together with prawns.

Mean DO was recorded in C_1 (4.4 mg/l to 4.5 mg/l) compared to the C_2 (3.8 mg/l to 3.9 mg/l) both during the morning and afternoon. Reasons might be photosynthesis that was hampered in C_2 due to shading by rice plants. Though DO was 3.8 mg/l to 3.9 mg/l by morning in C_2 which not hampered prawn cultivation as Avault (1986) stated that when DO levels fell to bellow 2 p.p.m. the prawns become stressed. All water quality parameters in both treatments were within suitable range for superior prawn production (Parvez[a] *et.al*. 2006, Swingle. 1961, Ali *et.al*.1988).

Effect of prawn farming on rice yield

The rice yield was lower in C_2 (treatment, prawn + rice, 1005 kg/hec) compared C_3 (control, only rice, 1115.5 kg/hec) although the difference was not significant ($p>0.05$). The reason might be less number of effective tillers in C_2 (9 number/tiller) in comparison to C_3 (9.75 number/tiller). The findings of the present investigation differ from the findings reported by Roy *et.al*. (1991). However the rice yield was found lower in comparison to the average national yield of Aus (Cv. Local) in Bangladesh of 1.7 t/hec (BBS 1996).

5. CONCLUSION

Freshwater is normally used for rearing freshwater prawns from post-larvae to marketable size. Beside the freshwater prawn, rice cropping in the same plot or field at the same time is additional income that added in national revenue. Higher yield of prawns was obtained from prawn farming within rice systems, compared to only prawn farming systems. The results of this experiment suggested that prawn yield could be increased by 18% if prawns are cultivated along with rice, and would not be obtained with this option. The study was conducted to meet understanding the new technology in regards of Economics (i.e. low) and yields of rice cum freshwater prawn (i.e. comparatively higher than control) in the gher farming system transfer aspects of culture practice that were evolved in improved culture practice.

6. RECOMMENDATION

These results can be readily explained to farmers with simple examples and observations. It is also recommended that the results should be shared in the farmers' group 'learning sessions' and scale out through national and international organization. A range of public and private sector investments and initiatives are needed to realize the potential for growth and expanding economic output from this sector. The realization of its potential must be aided by improvements in production technology. It will be helpful to increase farmer's profit margins, reduce the negative environmental impacts of challenging livelihood and increase job opportunities. The quantitative data presented earlier in this report show that the yields of gher farming is currently financially viable and generates considerable amounts of direct and indirect employment. Therefore research would be required as quantitative and qualitative environmental impacts for sustainable rice cum freshwater prawn farming.

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