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The sustainable livelihoods approach of freshwater prawn production in South-western Bangladesh

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Abstract
The present study was undertaken to determine the livelihoods aspects of freshwater prawn farmers based on production technology and economic feature of prawn production in two villages of Dumuria upazila namely Ghona Mader Danga and Ramkrishnapur from October 2002 to May 2003 in Khulna district. Based on a sample of 181 farmers from the two villages, 93.37% of farmers cultured prawn with fish in the integration of rice and dike crops. The culture period is typically nine months; mainly wild post larvae (PL) of prawn are stocked in April to June and harvested from December to February. Fish fry are partially stocked with the prawn fry. The average stocking density of PL was found to be 14,558 nos. /ha and the average stocking density of fish fry was 3,335 nos. /ha. Different types of feed such as rice bran, wheat bran, mustard oilcake, whet flour, soybean meal, fish meal, snail flesh, cooked rice, broken rice, etc. are mainly used in *ghers* for prawn feeding. The average yield of prawn and fish was 319 kg and 443 kg per hectare respectively. The freshwater prawn being a highly valued product for international market and therefore almost all prawn is exported, however fish are used for domestic consumption. Prawn farmers in the study area made a profit, with seed and feed dominating variable cost (average Tk. 27, 300/ha and Tk. 23,500/ha respectively). The average cost of *gher* operation was Tk. 76,015/ha and average net return was Tk. 93,152/ha. It was found that the farmers having own land obtained higher net returns than the leaseholders.

Keywords: Freshwater, farmers, *Macrobrachium rosenbergii*, ghers

1. Introduction
Fisheries play an important role in the social and economic life of the country providing food, employment and foreign exchange [1]. It contributes 5.3% to the GDP of the country while providing full time employment to approximately 1.2 million people (1% of the total population) [2]. In addition, a very large number of people are engaged in subsistence fishing and in activities related to the fisheries sector. Fish provides 80% of the animal protein intake of the people of Bangladesh. It is also a major earner of foreign exchange, contributing about 10% of the total export earnings most of which come from shrimp and prawn, ranging third in terms of importance after the garment and leather sectors [3].

In fisheries sector, freshwater prawn (*Macrobrachium rosenbergii*) has become one of the most important export products in Bangladesh. Therefore, the government had declared prawn cultivation a primary industry and designed specific support program to boost production. Both non-governmental organizations (NGOs) and Department of Fisheries (DoF) provide training, extension service and other facilities for the development of prawn production. Since 1980s, DoF has been working with a support of technical and training facilities for sustainability of prawn production and claims to be adding to the earning of foreign currency [2].

Prawn and shrimp are economically important for Bangladesh to provide 7.5% of the foreign currency in 1999-2000 [2]. The cultivation of freshwater prawns is highly valued product for the international market and therefore, almost all Bangladeshi prawns are exported. The USA, Japan and Europe especially Belgium, UK, Italy and Germany are the main markets for freshwater prawn, where the price of head-less prawn, ranges from US$ 6.75 to 21.25/kg [2]. There is great potential for successful freshwater prawn culture in southwestern Bangladesh. Nowadays, the production of prawn from natural sources is decreasing day by day. So,

Scientific prawn culture should be introduced. Most of the farmers in our country do not know the scientific method of prawn culture. In spite of that the number of *ghers* are increasing day by day for prawn culture in the southwestern Bangladesh.

Now-a-days, prawn culture is one of the important livelihoods approach in southwestern Bangladesh. Introduction to prawn culture has created more employment opportunities and offered greater income earning potential for community members, especially for the poor in the area. The primary activities of laborers include preparation of *gher*, snail collection and marketing, weeding, harvesting prawn and working as guards. However, there is a lack of effective government regulation and control over the existing prawn fry and prawn-marketing network in the country. The depot owners, in association with local agents control the prawn fry market in a monopolistic manner. Prawn traders and prawn processing plants, all of who manipulate the prices of prawn to maximize their profits, control the prawn-marketing network.

This study will generate base line information on livelihoods approach of prawn farmers in Khulna region, general feature of prawn culture systems, level of input use and its pricing, marketing, cost and returns, consequences and problems associated with prawn farming. The present study is conducted in 2 villages of Dumuria upazila in Khulna district. This study is expected to add some valuable information to the existing body of knowledge regarding prawn culture particularly with respect to the area under study. The results of the study are also expected to be helpful benchmark information for sustainable livelihoods research and will give direction for the development of prawn farming in Bangladesh.

2. Materials and Methods
2.1 Duration of the experiment
The experiment was survey related and data were collected by the author himself through personal interviews and Participatory Rural Appraisal (PRA) with the selected freshwater prawn farmers from October 2002 to May 2003.

2.2 Study Area
The study area was selected in most important freshwater prawn (*M. rosenbergii*) producing region, Khulna in the coastal Bangladesh. It was decided that the study would be conducted in two villages of Dumuria upazila namely Ghona Mader Danga and Ramkrishnapur. These selected villages have relatively homogeneous phygeographic conditions among the farm units and freshwater prawn (*M. rosenbergii*) was cultivated abundantly in these areas. Apart from this, these areas are well communicated from Khulna district town, these prawn farming areas are important due to the favorable resources and climatic conditions such as the availability of pond and low lying agricultural land, warm climate, fertile soil, and cheap and abundant labor.

2.3 Selection of the Sample
In a complete survey, the required information is collected from each and every elements of the population. Thus it becomes costly and time consuming. The normal practice therefore is to select a sample of representative freshwater prawn farmers which could represent a reasonably true picture of the prawn farmers and satisfy the objective set for the study. In this study, total 181 farmers were randomly selected,

among them 96 and 85 farmers were selected from Ghona Mader Danga and Ramkrishnapur village respectively.

2.4 Preparation of Survey Schedule
In a farm economic survey, preparation of survey schedule needs considerable care and expertise. In order to get a complete picture of the present prawn production and to fulfill the objectives of the study, a draft survey schedule was prepared and pretested with 10 farmers. The draft schedule was used for pre-testing a few sample farmers by the researcher. In this pre-testing, attention was paid to incorporate any new information, which was not designed to be asked and filled in the draft schedule. Thus the draft schedule was modified and improved in the light of the actual experience gained from the field. Finally, a set of items were listed and grouped in logical sequence of information designed to include both quantitative and monetary values of prawn production so that the prawn farmers could answer easily.

The question of the survey schedule were open-ended, there were some closed questions as well with a number of alternative replies. The schedule included questions on detailed information about the use of different inputs in connection with the production of prawn, i.e., returns from prawn cultivation, cost including prawn seed, feed, human labor, characteristics of *gher* (modified rice fields with high, broad peripheral dykes) and other related costs. All the questionnaires were constructed in English and then translated to Bengali during face-to-face interviews.

2.5 Data Collection
For this study, data were collected using questionnaire interviews, Participatory Rural Appraisal (PRA) tool such as Focus Group Discussion (FGD) and cross check interview with key informants were used for prawn farmers.

3. Results
3.1 History of Prawn Farming
According to the questionnaire survey of 181 farmers, 11 farmers (6.07%) started prawn farming before 1990 in the area, 43 farmers (23.76%) from 1991 to 1995, 96 farmers (53.03%) from 1996 to 2000 and 31 farmers (17.13%) started prawn farming after 2000. Table 1 shows the highest 48 farmers (56.47%) started prawn farming in Ramkrishnapur from 1996 to 2000, followed by 48 farmers (50%) in Ghona Mader Danga.

Table1: Starting year of gher farming by the prawn farmers

Starting year	Ghona Mader Danga	Ramkrishnapur	Total
Before 1990	8 (8.33%)	3 (3.52%)	11 (6.07%)
1991-1995	26 (27.08%)	17 (20%)	43 (23.76%)
1996-2000	48 (50%)	48 (56.47%)	96 (53.03%)
After 2000	14 (14.58%)	17 (16.47%)	31 (17.13%)

3.2 Prawn Farming Experience
According to the questionnaire interview, 134 farmers (74.03%) in the area acquired their experience for prawn farming from their friends and neighbors, 46 (25.41%) by self-study and only 1 farmer (0.55%) from NGO. Table 2 shows that the highest 67 farmers (78.82%) in the village Ramkrishnapur acquired prawn farming experience from their friends and neighbors followed by 67 farmers (69.79%) in Ghona Mader Danga.

Table 2: Gher farming experience acquired by the prawn farmers

Acquired experience	Ghona Mader Danga	Ramkrishnapur	Total
Self-study	29 (30.20%)	17 (20%)	46 (25.41%)
Friends & neighbors	67 (69.79%)	67 (78.82%)	134 (74.03%)
NGO	0 (0%)	1 (1.17%)	1 (0.55%)
Total	96 (100%)	85 (100%)	181 (100%)

3.3 Training
According to the survey, 146 farmers (80.66%) in the area did not get any training for prawn farming. Only 35 farmers (19.34%) got training on prawn farming from Department of Fisheries (DoF) and different NGOs like Agro-based Industries and Technology Development Project (ATDP), Cooperation for American Relief Everywhere (CARE), Bangladesh Rural Advancement Committee (BRAC) etc. Table 3 shows that highest 22 farmers (25.88%) got training in Ramkrishnapur village followed by 13 farmers (13.54%) in Ghona Mader Danga.

Table3: Training received by the farmers for prawn farming

Training obtained	Ghona Mader Danga	Ramkrishnapur	Total
Yes	13 (13.54%)	22 (25.88%)	35 (19.34%)
No	83 (86.45%)	63 (74.12%)	146 (80.66%)
Total	96 (100%)	85 (100%)	181 (100%)

3.4 Gher Ownership
In the study area, most of the farmers cultured prawn in their own *ghers*. According to questionnaire interview, 99 farmers (54.7%) cultured prawn in their own *gher*, 46 farmers (25.41%) cultured taking lease from others and 34 farmers (18.78%) cultured prawn both their own and leased *ghers*. Only 2 farmers (1.10%) cultured in *ghers*, the land of which was obtained from other sources including maternal property, *khash* land, dowry property obtained from fathers-in-law etc. Table 4 indicates that between the two villages, the highest 54 farmers (56.25%) in Ghona Mader Danga has their own land than 45 farmers (52.94%) in Ramkrishnapur for prawn farming.

Table4: Gher ownership by farmers in the study area

Gher ownership	Ghona Mader Danga	Ramkrishnapur	Total
Own	54 (56.25%)	45 (52.94%)	99 (54.7%)
Lease	25 (26.04%)	21 (24.71%)	46 (25.41%)
Both	16 (16.66%)	18 (21.18%)	34 (18.78%)
Others	1 (1.04%)	1 (1.18%)	2 (1.10%)
Total	96 (100%)	85 (100%)	181 (100%)

3.5 Production Technology
3.5.1 Gher area
The size of *gher* may play an important role as it may reflect the availability of capital, managerial ability and the potential to operate and use resources efficiently. In the study area, most of the farmers had small size *ghers*. Table 5 shows that the average *gher* size in the area was 0.77 ha. The highest average area was 0.79 ha in Ghona Mader Danga followed by 0.75 ha in Ramkrishnapur. There was no significant difference (P>0.05) between the average areas of *gher* in the study area.

Table 5: *Gher* size (ha) for prawn farming in study area

Gher size	Ghona Mader Danga	Ramkrishnapur	Total	
	Mean	Mean	Mean	SD
Area (ha)	0.79	0.75	0.77	0.84

SD: Standard Deviation

3.5.2 Gher type
In the study area, most of the *ghers* were perennial. Of the total 181 farmers interviewed, 178 farmers (98.34%) had perennial *gher* and only 3 (1.65%) had seasonal *gher*. The highest 93 farmers (96.88%) in Ghona Mader Danga had perennial *gher* followed by 85 farmers (100%) in Ramkrishnapur (Table 6).

Table 6: Type of *gher* for prawn farming

Gher type	Ghona Mader Danga	Ramkrishnapur	Total
Seasonal	3 (3.13%)	0 (0%)	3 (1.65%)
Perennial	93 (96.88%)	85 (100%)	178 (98.34%)
Total	96 (100%)	85 (100%)	181 (100%)

3.5.3 Gher management
Gher management is an important factor for better production. In the study area, most of the farmers do not manage *gher* properly for prawn farming. Their *gher* management includes drying of gher bottom, construction of dikes, removal of black soil after complete harvesting, cleaning of *gher*, ploughing, application of lime and fertilizer, etc. which is only followed by 45% farmers. Most of the farmers (86.19%) do not acclimatize Post Larvae (PL) before releasing it into the *gher* and 35.36% of farmers do not apply fertilizer into the *gher*. The feeding rate and frequency of many *ghers* was insufficient and irregular in the study area. Farmers do not exchange water of the *gher*, although most of them do not have the facility of water exchange or introduction.

3.5.4 Culture season and methods
In the study area the peak season of prawn farming is from April to December. Prawn post-larvae are stocked in the *gher* from April to June and are harvested from December to February.

From the questionnaire survey, it was found that 169 farmers (93.37%) followed integrated prawn culture method (Prawn + Fish + Rice), 11 farmers (6.08%) followed polyculture (Prawn + Fish) method and only 1 farmer (0.55%) followed monoculture (only Prawn) method. In integrated culture method, rice is generally cultured before the prawn culture in the *gher* from January to April. As shown in Table 7, the highest 90 farmers (93.75%) followed integrated culture method in Ghona Mader Danga than 79 farmers (92.94%) in Ramkrishnapur.

Table 7: Culture methods followed by farmers for prawn farming

Culture methods	Ghona Mader Danga	Ramkrishnapur	Total
Prawn	1 (1.04%)	0 (0%)	1 (0.55%)
Prawn + Fish	5 (5.21%)	6 (7.06%)	11 (6.08%)
Prawn + Fish + Rice	90 (93.75%)	79 (92.94%)	169 (93.37%)
Total	96 (100%)	85 (100%)	181 (100%)

In the study area, the main crops found to be integrated by the prawn farmers in the gher and on the dikes of the gher were rice and vegetables respectably. It was found that 175 farmers (96.69%) among 181, cultured rice in their gher. The main types of rice are High Yielding Varieties (HYV) Boro. Again, 156 farmers (86.19%) cultured vegetables on the dikes of their gher all-round the year.

3.5.5 Source of PL/Juvenile and fish fry
The main source of prawn fry or post larvae (PL) in the study area is natural or wild fry, which is collected by fry collectors from the coastal areas. Fry traders go to the farmers to sell PL. Sometimes the farmers themselves go to the fry collectors directly to buy prawn fry. They buy their prawn fry from different depots near their villages. Few farmers stock hatchery fry besides wild fry. They collect juveniles from traders. Some farmers also stock some post larvae at the middle of the culture season, which become juvenile in the first year. These juveniles grow out in the second year. From the survey result, it was found that 165 farmers (91.16%) stock natural fry in their *ghers* and 16 farmers (8.84%) release both natural and hatchery fry. Table 8 shows that the highest 88 farmers (91.67%) release natural fry in their *ghers* in Ghona Mader Danga followed by 77 farmers (90.59%) in the Ramkrishnapur. The sources of their fish fry are hatcheries and they buy the fish fry from the fish fry traders.

Table 8: Source of PL/Juvenile

PL source	Ghona Mader Danga	Ramkrishnapur	Total
Natural	88 (91.67%)	77 (90.59%)	165 (91.16%)
Hatchery	0 (0%)	0 (0%)	0 (0%)
Both	8 (8.33%)	8 (9.41%)	16 (8.84%)
Total	96 (100%)	85 (100%)	181 (100%)

3.5.6 Stocking densities
The average stocking density of PL and juvenile in the study area was 14,559 nos./ha among which the average stocking density of PL was 12,906 nos./ha and juvenile was 1,653 nos./ha. As Table 9 indicates the average stocking density of PL and juvenile in Ghona Mader Danga was 12,968 nos./ha and 1,641 nos./ha respectively followed by 12,844 nos./ha and 1,664 nos./ha in Ramkrishnapur. There was no significant difference (P>0.05) in stocking densities between the two villages. The farmers mainly stock silver carp, rohu, catla, mrigel, grass carp, carpio, etc. with prawn in the *gher*. The average stocking density of fish fry in the study area was 3,335 nos./ha measuring 2 to 5 inches of each fry.

Table 9: Stocking of PL, juvenile and fish fry nos./ha

		Ghona Mader Danga	Ramkrishnapur	Mean	SD
Prawn fry	PL	12968	12844	12906	5278
	Juvenile	1641	1664	1653	1097
	Total	14609	14508	14559	5765
Fish fry		3210	3460	3335	2136

SD: Standard Deviation

3.5.7 Feed and feeding rates
The farmers use different types of feed in their *ghers* viz., snail flesh, cooked rice, rice, wheat, etc., and mixture of rice bran, fishmeal, soybean meal, mustard oilcake, coconut oilcake, flaked rice, etc. According to questionnaire survey on 181 farmers, 87 farmers (48.07%) use snail flesh, 34 farmers (18.78%) prefer formulated feed or mixture of different ingredients, 34 farmers (18.78%) prefer rice bran, 21 farmers (11.60%) prefer cooked rice and only 5 farmers (2.76%) prefer others to feed prawn and fish. Table 11 shows that, 50.59% farmers prefer snail flesh to feed prawn in Ramkrishnapur village followed by 45.83% in Ghona Mader Danga. Most of the farmers apply feed once in a day (in the afternoon) except 12.6% farmers twice in a day (morning and afternoon). The average feeding rate in the study area was 14.93 kg/ha/day.

Table 10: Preferred feed for prawn farming by the farmers

Name of the feed	Ghona Mader Danga	Ramkrishnapur	Total
Snail flesh	44 (45.83%)	43 (50.59%)	87 (48.07%)
Formulated feed	20 (20.83%)	14 (16.47%)	34 (18.78%)
Rice bran	15 (15.63%)	19 (22.35%)	34 (18.78%)
Cooked rice	14 (14.58%)	7 (8.24%)	21 (11.60%)
Others	3 (3.13%)	2 (2.35%)	5 (2.76%)
Total	96 (100%)	85 (100%)	181 (100%)

3.6 Harvesting and marketing
The harvesting of prawn starts from month of December and ends with February. The peak season of prawn harvesting in the study area is January to February. Farmers harvest prawn about 5-6 times on an average in their *ghers* at few weeks' interval. For harvesting of prawn, they use cast net, seine net and finally they pump out their *ghers*. According to the 181 interviewees, 167 of them (92.27%) sell their prawns directly to the prawn traders in depots. Sometimes the depot owners/traders come to the farmers' house to buy prawn. Only 12 farmers (6.63%) sell of their prawn to the both open market by bid and to the prawn traders. The price of the prawn depends on the size or grade and it varies between Tk 170 to 550 per kg. The prawn from the depot owners or traders goes to the processing plants directly or via agents. The prawns are processed and packed in the plants and then exported to the foreign countries especially USA, Japan and European markets.

3.7 Production of prawn and fish
The average production of prawn and fish in the study area was 319 kg/ha and 443 kg/ha respectably. Table 11 shows the highest average production of prawn was 324 kg/ha in Ghona Mader Danga followed by 319 kg/ha in Ramkrishnapur. The highest average production of fish was 447 kg/ha in Ramkrishnapur followed by 439 kg/ha in Ghona Mader Danga. There was no significant difference (P>0.05) in prawn and fish production between the two villages. It was observed that the production was positively related with stocking densities.

Table 11: Average production of prawn and fish (kg/ha)

	Ghona Mader Danga	Ramkrishnapur	Total	
Prawn	Mean	Mean	Mean	SD
	324	314	319	130
Fish	439	447	443	677

SD: Standard Deviation

3.8 Cost-return Analysis of Prawn Farming
3.8.1 Cost structure
Table 12 shows that the average total cost of prawn farming in the study area was Tk 76,156/ha. The highest average cost of prawn farming was Tk 76,156/ha in Ramkrishnapur followed by Tk 75,873/ha in Ghona Mader Danga, however, there is no significant differences. Among the costs structure, the cost of seed/fry (prawn and fish) (Tk 27,300/ha) and cost of feed (Tk 23,500/ha) dominated all other costs.

Table 12: Average costs for operating per ha of *gher* by the sampled farmers (Tk).

Items	Ghona Mader Danga	Ramkrishnapur	Total Mean	SD
Seed/fry	27432	27168	27300	10214
Feed	23288	23712	23500	12986
Fertilizers	482	470	476	462
Labors	1550	1507	1529	804
Harvesting & marketing	1257	1305	1281	726
Rice cultivation	9040	9018	9029	1430
Salary of management staff	653	720	687	1982
Interest	2765	2845	2805	6331
Depreciation	1051	1157	1104	1116
Others	8355	8254	8305	6373
Total cost	75873	76156	76015	21045

SD: Standard Deviation

3.8.2 Return structure
Table 13 shows the return structures from prawn, fish, paddy and dike crops in the study area. The table indicates that the average return from prawn, fish, paddy and dike crops were Tk 106876, 18818, 33545 and 9927 per ha respectably. Among structures of the return, the highest average return was from prawn Tk 110108/ha in Ghona Mader Danga followed by average Tk 103645/ha in Ramkrishnapur.

Table 13: Average return from per ha of *gher* in the selected areas (Tk)

Items	Ghona Mader Danga	Ramkrishnapur	Total Mean	SD
Prawn	110108	103645	106876 (63.18%)	45837
Fish	17055	20581	18818 (11.12%)	12608
Paddy	33943	33146	33545 (19.83%)	13593
Dike crops	8138	11717	9927 (5.87%)	13680
Gross revenue	169243	169089	169166 (100%)	53530

Figure in the bracket indicates percentage of the gross revenue.
SD: Standard Deviation

3.8.3 Profitability of prawn farming
The average net return from prawn farming in the study area was Tk 93152/ha. Table 14 shows that the highest average net return from prawn farming in the area was Tk 93370/ha in Ghona Mader Danga followed by Tk 92933/ha in Ramkrishnapur. There was no significant difference (P>0.05) in net return between the two villages in the study area.

Table14: Costs and return of *gher* farming per ha of the selected areas (Tk)

	Ghona Mader Danga	Ramkrishnapur	Total Mean	SD
Gross revenue	169243	169089	169166	53530
Total cost	75873	76156	76015	21045
Return	93370	92933	93152	43969

SD: Standard Deviation

Among 181 farmers interviewed in the study area, 100% farmers thought that prawn farming is more profitable than agriculture, 159 farmers (87.85%) thought that prawn farming is more relax than agriculture, whether 22 farmers (12.15%) thought prawn farming is laborious than agriculture. Of them, 126 farmers (69.61%) expressed positive willingness of conversion of *gher* if they had more land, on the contrary 55 farmers (30.39%) expressed negatively.

3.9 Problems of Prawn Farming
From the questionnaire survey it was found that most of the prawn farmers face economic problems, which is single most important problem to them for prawn farming. Table 16 shows that 144 farmers (79.56%) identified lack of money is the single most important problem for prawn farming, 17 farmers (9.39%) identified lack of PL, 13 farmers (7.18%) identified higher cost of feed and 7 farmers (3.87%) identified lack of technical knowledge was the main problem for prawn farming.

3.10 Environmental Impacts
Most of the farmers in the study area are not concerned about the environmental impact of prawn farming. From the village leaders, school and collage teachers, educated farmers, it was identified that water logging is the main environmental impact due to unplanned *gher* construction for prawn farming. Also they said that the indigenous fisheries have tremendously decreased due to construction of *ghers*. The farmers also reported that they face problems for transportation of crops, prawn and fish from their *gher* as most of the *khals* have converted to *ghers* by some muscle man. The numbers of cattle in the area have decreased, as there is not enough land for grazing of the cattle.

3.11 Socio-economic Condition of Prawn Farmers
3.11.1 Age Structure of Prawn Farmers
In the study area it was observed that most of the prawn farmers were quite young with an average age of 36.09 ranging from 17 to 60. The highest average age was found in Ghona Mader Danga (36.89) followed by Ramkrishnapur (35.29). The differences of average age of the farmers between the two villages were no significant (P>0.05). Of the interviewed farmers, 5 farmers (2.76%) were less than 20 years, 55 farmers (30.38%) were 21 to 30 years, 63 farmers (34.80%) were 31 to 40 years, 48 farmers (26.52) were 41 to 50 years and 10 farmers (5.52%) were greater than 50 years. The highest percentages in both village were 31 to 40 age groups, Ghona Mader Danga having the highest numbers (32 farmers (33.33%)) in this age group (Table 17).

3.11.2 Religion
In the study area, 100% prawn farmers were Hindu. The area was mainly Hindu dominated, although there were few families of Muslims and Christians. But they were not involved in prawn farming rather than other occupations.

3.11.3 Improvement of socio-economic conditions
The survey suggested that 168 farmers (92.81%) have improved their socio-economic conditions through prawn farming. As table 18 shows, the highest percentage of farmers have improved their socio-economic condition was found in Ghona Mader Danga (93.75%) followed by Ramkrishnapur (91.76%). However, differences between zones were no significant (P>0.05).

4. Discussion

Prawn culture is an industrial revolution in the aspect of economy of Bangladesh. In fisheries sector, freshwater prawn has become on the most important export product in Bangladesh. Importance of prawn culture for renovation of poverty, employment and for the improvement of socio-economic conditions is unquestionable. Frozen shrimps and prawns are economically important for Bangladesh to provide 4.6% of the foreign currency in 2001-2002 [4]. Freshwater prawns have a great demand in the international market and almost all Bangladeshi prawns are exported. Keeping this view in mind, freshwater prawn is cultivated in the South-western Bangladesh.

In the present study the average stocking density of prawn fry (post larvae and juvenile) in the area was 14,559/ha. Mc Ginty and Alston [5] reported the average stocking density 25,000 PL/ha is suitable for prawn farming. In another study Tidwell *et al.* [6] found that 19,670 PL/ha gave good result. The stocking density of present study was lower than the above findings. Farmers used different types of artificial feed in the present study viz., fishmeal, rice bran, wheat bran, mustard oilcake, wheat flour, soybean meal, cooked rice, broken rice etc. Boonyaratpalm and New [7] got better production when fish was cultured by using soybean mal, corn meal, broken rice, and rice bran. In another study, Tidwell *et al.* [8] used fishmeal with oilcake and rice bran and concluded this feed is suitable for prawn culture. Average production of prawn in the study area was 319 kg/ha (Table 12). In a study Jose *et al.* [9] observed that the production of prawn was 279 to 408 kg/ha. In another study, Hoq *et al.* [10] reported that the production of freshwater prawn were ranged from 162 to 428 kg/ha. D'Abramo and Daniels [11] stated that the average production of prawn was found 405 kg/ha. The result of this study was similar to the above studies.

The average cost of prawn farming in the study area was Tk. 76,804 per hectare. Among the costs of different items, seed/fry (Tk. 27,530 per ha) and feed (Tk. 22,770 per ha) dominated all other costs. Uddin [12] reported that the average total cost of traditional farm was Tk. 49,713 per ha in 1995. In another study he stated that the cost for improved traditional method was Tk. 82,026 per ha in 1995. Miah [13] showed that the per hectare production cost was Tk. 47,779. The cost of *gher* operation per hectare in the present study was more or less same to the above studies.

In the present study, the average net return from prawn farming was Tk. 92,363 per ha (Table 15). Uddin [12] in a study noted that the average return from of prawn production was Tk. 55,878 per ha. In another study, Ahmed [14] reported that maximum profit by farmer could procure around Tk. 50,000 per ha. In a study Miah [13] mentioned that the net return of prawn farming was Tk. 77,226 per ha. The result of present study was higher than the above findings.

According to the survey, 144 farmers (79.56%) identified lack of money is the most important problem for prawn farming while 17 farmers (9.39%) identified lack of PL, 13 farmers (7.18%) identified higher cost of feed and 7 farmers (3.87%) identified lack of technical knowledge was the main problem (Table 16). Das [15] studied on the problems of prawn farmers to produce prawns and noted that the main problems were non-availability of scientific methods of prawn farming, lack of credit, inadequate supply of prawn seeds and lack of marketing facilities. In a study, Mahmud [16] also identified that the farmers have faced some constraints of prawn farming such as lack of institutional credit, higher price of inputs, poor scientific knowledge and lack of marketing facilities. Problems of prawn farmers in the present study were similar to the above result.

According to the prawn farmers, 92.81% of them have improved their social and economic conditions through prawn farming (Table-18). Now they have better food, cloths, housing conditions and children education. Islam *et al.* [17] found that the people of prawn farming obtained socio-economic benefit from prawn production. In another study conducted by Miah [13] and reported that 90% farmers and related people were economically and socially benefited due to prawn farming. As an impact of prawn farming savings, investment and purchasing capacity of farmers have increased and unemployment problems has decreased for both men and women. The present result was similar to the above results.

5. Conclusion

Freshwater prawn brings social and economic benefits for farmers, however concerns arise about the long-term sustainability of prawn farming due to high production costs, poor financial resources, scarcity and high cost of PL, lack of technical knowledge, poor institutional support, poaching of prawn, lower market price of prawn and inadequate extension services. So to overcome these findings it is essential to arranged proper training on shrimp culture for the farmers, credit facilities will be managed for farmers, to establish prawn hatcheries, to develop sound marketing facilities both for inputs and outputs so that the farmers can have fair prices round the year. Finally, if more areas could be brought under prawn cultivation, the country could probably have earned a huge amount of foreign exchange by exporting prawn.

6. References

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