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Journal of Advanced Scientific Research

Available online through http://www.sciensage.info/jasr

ISSN
0976-9595
Research Article

IMPACTS OF INTEGRATED RICE-PRAWN-FISH CULTURE TECHNOLOGIES ON THE LIVELIHOOD OF RURAL FARMERS

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ABSTRACT

Rice-prawn/fish culture practice has been established in southern parts of Bangladesh since 1990's, but very new in North-central region. This study was conducted with a view to describe the impacts of rice-prawn-mola-carp polyculture technology on the livelihoods of poor and marginal farmers of Gouripur Upazila in Mymensingh district, based on sustainable livelihoods framework. Freshwater prawn *(Macrobrachium rosenbergii)* and mola (*Amblypharyngodon mola*) also called small indigenous fish species (SIS) are important fisheries resources of Bangladesh. These species were introduced in rice-fish culture system of 15 farmers in the study areas. Socio-economic data were collected after completion of the experiment. Almost all the prawn farming households reported that the introduction of rice-prawn/fish culture technology ensured regular supply of SIS and large fish for home consumption, which played an important role in combating protein and micronutrient deficiency for poor, marginal and sub-marginal rural households. Another aspect of rice-prawn/fish culture technology was that it provided rapid return of investment by selling of freshwater prawn/fish and created opportunities for household savings.

Keywords: SIS, PFH, NPFH, Livelihood, Socioeconomic

1. INTRODUCTION

Rural development, the process of sustained growth of the rural economy and improvement of well being of rural men, women, and children, has various dimensions, but it is particularly the development of agriculture sector, which is widely believed to provide the main source for ensuring food security, reducing poverty and hunger. Fish are rich in protein, fatty acids, and essential vitamins and minerals which are important for the cognitive and physical development of humans. Small indigenous fish species (SIS) have been found to be much more nutrient-dense than cultured fish, such as carps. Nutrient analyses of common Bangladesh SIS as mola (*Amblypharyngodon mola*) has shown that the contents of vitamin A, calcium and iron are much higher than in cultured fish [1, 1a, 1b]. These nutrients in fish are found to be highly boiavailable. Moreover, SIS is self recruiting and therefore can be harvested weekly and biweekly, favouring household consumption.

Bangladesh is a land rich in inland water resources that are suitable for the culture of many aquatic species, including the giant freshwater prawn, *Macrobrachium rosenbergii*. In response to the high export potential of this species, the government of Bangladesh has launched an initiative to increase prawn production to 60,000 mt in 80,000 ha of low-lying floodplains and homestead ponds over the next 10 years. A recent survey showed that annual prawn yields are in the range of 300-600 kg/ha, which is relatively low; however this production can be increased through improved management and diversification of technologies.

Various types of aquaculture form have been evolved over the period of time as an important component within agricultural and farming systems development. They can contribute to the alleviation of food security, malnutrition and poverty through the provision of food of high nutritional value, income and employment generation [2, 2a].

Culture of fishes in rice fields is now a proven technology in Bangladesh. Incorporation of freshwater prawn into this system will surely increase the chance of getting more profit. Bangladesh is considered one of the most suitable countries in the world for freshwater prawn (*Macrobrachium rosenbergii*) farming, because of its favorable resources and agro-climatic conditions [3] and one of the most important sectors of the national economy especially because of export potential [4] particularly to the USA, Europe and Japan [5]. A sub-tropical climate and a vast area of shallow water bodies provide a unique opportunity for freshwater prawn production [6]. In Bangladesh, 65% of the people are poor and with limited lands [7]. Moreover, as the water bodies are shrinking with the passes of time in our country [8], fish culture in rice fields would play a key role here in maintaining aquaculture production. The practice of small-scale prawn farming in rice fields is widespread in south-west Bangladesh due to the

availability of wild post larvae and low-lying rice fields, a warm climate, fertile soil, and cheap and abundant labor [3]. Fish culture in suitable rice fields can reduce poverty, improve paddy yield, creates employment opportunity, increases nutrient intake which brings food security for farmers [9]. Shrimp culture is popular and widely used practices in the southern part of Bangladesh.

Bangladesh has more than 2.71 million ha of floodplain where water remains for 4-6 months [10]. In the most cases only boro rice crop is grown in these fields and are kept fallow for rest of the year. These rice fields have great potential for both concurrent and alternate method of rice-fish/prawn culture. Though fish is the main source of protein for the rural poor, but they don't have enough money to purchase it for daily consumption. Many of them catch wild fish from ditches, canals, rice fields, floodplains, beels, haors and baors for their normal diet [11, 11a]. Small-scale aquaculture is by far the most practiced form of aquaculture in the poorer communities in Bangladesh. The millions of small-scale farm families need to generate more food and livelihood opportunities from their current land and aquatic resources in order to be capable for wider economic development [12]. Therefore, the present study was undertaken to evaluate the socioeconomic conditions of the prawn/fish producing households and non-prawn/fish producing households, and to assess the socioeconomic and nutrition upliftment of rural households through adoption of freshwater prawn-carp-mola polyculture technology in rice fields.

Frame Work Of The Study: Livelihood comprises the capabilities, the assets (natural, physical, human, financial and social relations), the activities and the accesses to these (mediated by institutions and social relations) that together determine the living gained by the individual household [13] (Fig. 1).

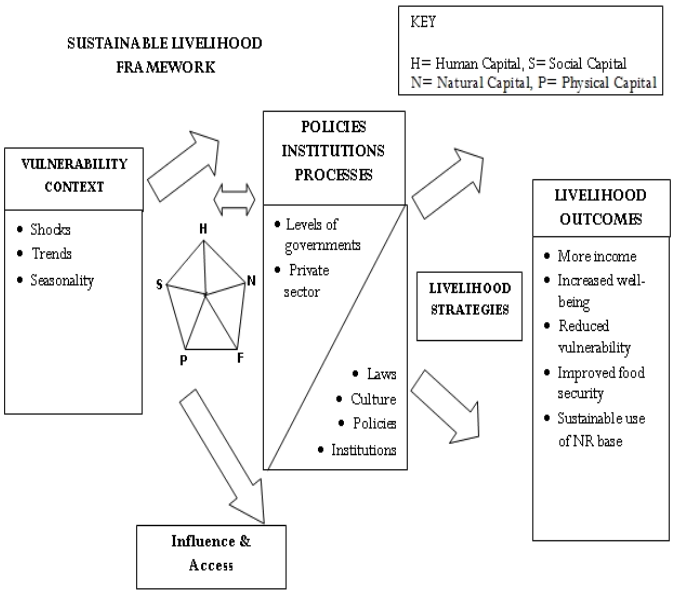

Fig 1. Sustainable livelihoods framework.

In this study, the livelihood framework has been used to understand the importance of freshwater prawn and small fish mola (*A. mola*) for each wealth class in the community, especially the poor. Figure 1 showed the livelihood framework and its various factors that constrain or enhance livelihood opportunities and show how they relate to each other. The framework provides a way of thinking through the different influences (constraints and opportunities) on livelihoods, and ensuring that important factors are not neglected [14].

2. MATERIALS AND METHODS

2.1. Selection of the study area

The study was conducted in Gouripur upazilla in Mymensingh district in the Division of Dhaka, Bangladesh lies between 24°45′30″N and 90°34′30″E (Fig. 2). Gauripur has 48378 units of household, 13 Unions/Wards, 277 Mauzas/Mahallas, and 278 villages and total area 274.07 km². Among the 278 villages two villages - Dauki and Damgaon were considered for this study.

Fig 2. Map indicating the study area

2.2. Study method

Field survey was carried out during the period of study. For the present study a total of 90 farmers were randomly selected. Out of them 45 fish farming household were selected and introduced rice-prawn-fish culture technology among them and then another 15 households were selected who are not associated with fish farming.

A standard questionnaire was purposively developed, pre-tested and finalized for data collection. A combination of participatory qualitative and quantitative methods was used for data collection. Data were collected in two times- before intervention of the project and after completion of the project. The Participatory Rural Appraisal (PRA) and Focus Group

Discussion (FGD) were conducted with rice-prawn-mola fish farming household (FFHH) and non fish farming household (NFFHH). FGD was used to get an overview of particular issues such as existing practices of rice-prawn-mola farming, socio-economic conditions and livelihood situation. A total of 10 FGD sessions were conducted where each group had 5 to 8 persons and duration was approximately two hours. Forty farmers were interviewed at their houses or farm sites. The interviews focused on farming systems, productivity, production technology, fish consumption, production constraints, and livelihood outcomes etc. Structured house hold level baseline questionnaire survey was done before intervention and also has done after the completion of the project activities.

2.3. Statistical analysis

Mainly two techniques were used in this study: tabular and statistical analysis. Tabular analysis included rice-prawn-mola culture practices, input use, cost and return of fish farming and socio-economic characteristics of fish farming and non fish farming households. Student's t-test was used for comparison of mean performances of the fish farming house hold and non fish farming households on fish production and their aquaculture knowledge [15].

3. RESULTS AND DISCUSSIONS

Different combinations and components of capital assets are required for people to engage in rice-prawn-fish farming in rural Bangladesh. The sustainable livelihoods framework draws attention to five types of capital upon which rice-prawn-fish farming farmers' livelihoods depends: physical, human, natural, financial, and social [16, 17].

3.1. Physical capital (pond and rice field)

Pond and rice field have been considered as physical asset. The average pond area of the farmers of prawn farming group found to be 0.24 ha (53.3 decimals) with the highest 1.13 ha (280 decimals) and lowest 0.061 ha (15 decimals) whereas the average area of non-prawn farming group farmers found to be 0.11 ha (26.3 decimals) with the highest 0.20 ha (50 decimals) and lowest 0.04 ha (10 decimals). The average area of rice fields of the farmers of prawn farming group was 0.81 ha (201.3 decimals) with the highest of 2.59 ha (640 decimals) and with the lowest of 0.081 ha (20 decimals) whereas the average area of rice fields of the farmers of non-prawn farming group was 0.52 ha (129 decimals) with the highest of 0.81 ha (200 decimals) and with the lowest of 0.22 ha (55 decimals).

3.2. Human capital

Human capital represents the skills, knowledge, ability to labor and good health that together enable people to pursue their livelihood strategies [14]. As well as being of intrinsic value, human capital is required in order to make use of any of the four other types of asset [18]. In the rice-prawn culture sector, landless, marginal and sub-marginal farmers are poor as well as health also. The respondent households had an average family size of 5 persons, 54% male and 46% female. Although primary education is compulsory in Bangladesh, not all children could attend school because of poverty. Children provided household labor and, in some cases, schooling costs were unaffordable. Literacy level did not show any significant difference between prawn farming household and non-prawn farming household.

3.3. Natural capital: access to land and ponds

According to the survey, most of the households had a single pond. The average area of pond was found to be 0.15 ha. Farmers relied on rainfall and groundwater for Carp-SIS farming. Some respondents had a very few land; the maximum landholding was 0.668 ha. Thus, the groups comprised marginal and sub-marginal farmers and there was no landless farmer. Most of the ponds were more than 12-15 years old and had previously been used for fish farming, but mainly only by stocking without fertilization or supplementary feeding and not followed any fish culture technology. Rain water was the main source of fish culture together with groundwater. The ponds were perennial and flood free and the respondent reported no conflicts over water. Rice-fish culture is a new intervention in the research area.

Financial capital denotes the financial resources that people use to achieve their livelihood objectives [5]. Financial capital of rice-prawn farming represents the incomes, savings, credits, etc. The rice-prawn polyculture system has the potential to generate considerable amounts of financial capital. Annual income prawn farming households found significantly higher after intervention than baseline survey.

3.4. Social capital

Almost all community people were disadvantaged in social capital such as the networks, groups, trust, access to institutions, etc. Regarding social benefits, majority of the farmers reported that additional income from prawn/fish culture made them solvent and provided scope to have better relation with family members as well as in the society as a whole. Moreover, the income derived from fish culture enabled the farmers to support their children's education. All the prawn/fish culture farmers were happy with rice-prawn/fish culture, as it does not affect other household works.

3.5. Culture season and method

In the study area May to November is the main fish farming season. Fish fingerlings were stocked when they became available usually in May-June. Maximum farmers overstocked with smaller sized fingerling without following any advanced aquaculture technology. The species mainly cultured in different polyculture systems includes rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus*), Silver carp (*Hypophthalmichthys molitrix*), Grass carp

(*Ctenopharyngodon idella*), Common carp (*Cyprinus carpio* var. *communis*), Mirror carp (*Cyprinus carpio* var. *specularis*), Thai sharputi (*Puntius gonionotus*), Thai pangus (*Pangasius hypophthalmus*), Tilapia (*Oreochromis niloticus)* and Thai koi (*Anabas testidineus).*

In case of rice-fish culture systems people usually followed alternate method of rice-fish culture systems, i.e. they grow rice in dry season (between January and May) and culture fish in wet season (between June and December) in the same land. Most of the farmers made 3-4 feet high embankments surrounding their rice plots and grow vegetables on the dyke. Main cultured species are similar as used in the pond. Freshwater prawn is introduced in the rice-fish culture systems in these villages through the intervention of the experiment.

Before intervention, nobody prepared their pond properly and the average stocking density was found to be 25000 ha^{-1} of carps and other species. After intervention, average stocking density was 15000 ha^{-1} of freshwater prawn and 20000 ha^{-1} of mola in concurrent rice-fish culture system, but in alternate method of rice-fish culture system stocking density of prawn was 20000 ha^{-1} with mola 20000 ha^{-1} and carp 2500 ha^{-1}.

To enhance fish production, it is essential to apply supplementary feed throughout the culture period. Before intervention the study, 50% of the respondents applied feed irregularly without maintaining any particular doses and time (not daily basis), and the rest 50% did not apply any feed; nobody applied urea and TSP but cow dung was used by only 22.5% of the respondent. After completion of the experiment, 100% farmers used supplementary feed for fish and prawn at daily basis. Urea and TSP and cow dung were applied at a 10-15 day intervals.

To observe the socio-economic impacts of rice-fish-prawn culture technology, 30 farmers were interviewed before and after intervention of the rice-fish-prawn culture technology. After baseline survey freshwater prawn and SIS were introduced in rice-fish culture system of 15 farmers' rice field out of 30 farmers. The farmers did not have previous knowledge on the carp-prawn-SIS culture technology. All the 30 farmers' data were collected after completion of the project according to the socio-economic questionnaire. The differences between the two sets of data allowed evaluating the impact of the technology.

Consumption of large carps and SIS increased significantly among the rice-fish-prawn culture group after intervention of the research than the baseline survey (Table 1). As well as their income from the rice field also differ significantly before and after intervention of the research. But there were no significant differences of fish consumption and income from rice fields among the farmers of non prawn culture group between baseline survey and after one year survey.

Average annual income of prawn farming group significantly increased after intervention of the research work than the baseline survey. But annual income of non-prawn farming group did not show any significant differences between baseline survey and the survey after intervention of the research project (Fig. 3).

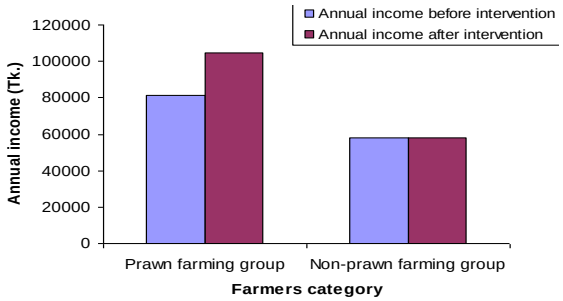

Fig 3. Comparison of economics between before and after intervention of the experiment.

Table 1. Comparison of fish consumption between prawn farming households (PFH) and non prawn farming households (NPFH).

Households	Before intervention	After intervention	Difference in g/person/day	Difference in %
	Average (g/person/day)	Average (g/person/day)		
PFH	31.9	53.8	21.9	68.7
NPFH	39.5	44.5	5.0	12.7

3.6. Constraints of fish production

Several problems were also mentioned by the respondents during FGDs. Major problems identified were lack of capital, high price of prawn seed, low growth and high mortality of prawn post larvae (PL), scarcity of snail in natural sources for feeding, high and uprising price of supplementary feeds and fertilizers but low price of fish, inadequate technical knowledge and high rate of lease value of pond. Fish disease is another constraint for fish-prawn farming. Identification of problems and constraints are the prerequisites for mitigating any problems to enhance aquaculture production [19]. Problems of low growth, high mortality and high price of feeds in aquaculture practice of Bangladesh were not new; all were reported by Mohsin et al. [19] earlier while working with carp culture in ponds. Ali [20] mentioned that excess and indiscriminate application of various antibiotics for the treatment of PL in hatcheries after hatching was responsible for the low growth of prawn. He also reported that this problem became severe after 2010 in Bangladesh. As the farmers in the study area did not collect PL directly from the

hatcheries and they had to rely on middlemen for the collection so they did not get any opportunity to choose PL according to their preference.

4. CONCLUSION

Malnutrition is the major problem in third and fourth world. Although number of small species found in this country which is very rich in Vitamin and minerals. Recently small scale aquaculture has been emerged in many countries especially where rural people dominates the country and recognized that the small scale fish farming system is fruitful to contribute to the food security, mal-nutrition, employment generation and ultimately the poverty alleviation and rural development but very little emphasis paid on conservation, production and consumption of SIS. Consumption of both SIS especially mola as well as Carp and prawn were increased in household after implementation of this experiment thus helping to improves health and economic condition of poor peoples.

Low-laying rice fields can effectively be used for integrating prawn and finfishes with rice production. It can bring more profit to the farmers than prawn polyculture with carp species in ponds. However different crops (rice, prawn and finfishes) may help to meet up the diversified demands for foods. This technology would not pose any salinization threat to environment that shrimp culture threatening at present. As no saline water is essential for prawn culture, the technique may spread out to all over the country. But use of snail as food for prawn is badly affecting the abundance and existence of snail community. Alternate food source is essential which will replace snail community and ensure conservation of snails. However, further research efforts, initiatives by the government and concern authorities are also recommended to mitigate the existing problems to ensure sustainability of the technology.

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