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INTEGRATED PRAWN-AGRICULTURE GHER FARMING SYSTEM IN BAGERHAT, BANGLADESH

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Abstract: Freshwater prawn farming has become an important component in the livelihood of marginal farmers in the freshwater interface of Southwestern coastal Bangladesh. This prawn farming has been integrated with rice and/or vegetable either simultaneously or sequentially. In an attempt to assess the status of integrated prawn-agriculture *gher* farming in the area, 20 farms at Fakirhat Thana, Bagerhat were surveyed during August-October, 2005. Farmers were interviewed with questionnaire on the production and economics of such integrated farms. Stocking of prawn PL was done at the densities 0.5 to 2.0 PL m^{-2} during February-March in simultaneous culture and at the densities 3.0 to 7.0 PL m^{-2} during June-July in sequential system. This integrated prawn farming has beneficial impact on the income of the farmers. Net profit was calculated to be Tk 20,395 ha^{-1} from a cycle (5-6 months) of simultaneous culture and Tk 35,457 ha^{-1} from sequential system, and Tk 127,000 ha^{-1} from rice + prawn + vegetable farming.

Key words: Integrated farming, rice, prawn, livelihood, coastal Bangladesh

Introduction

Fish culture started from the need to supply fish when the production from capture fisheries had been depleting due to over exploitation, environmental pollution and many other reasons. Time, technology and state of demand have changed the concept of fish culture into aquaculture. Freshwater prawn (*Macrobrachium rosenbergii*), locally known as galda, has emerged in the last few years as one of the most important aquatic resources in coastal Bangladesh. Well adaptability, fast growth, high nutritional value and omnivorous feeding habit have made it an excellent species for polyculture. It has also very high demand both in domestic and international markets.

Aquaculture was going on through its own track until unless the concept of integrated farming emerged. Integrated fish farming is a type of aquaculture with different di-commodity, tri-commodity or multi-commodity combinations like fish with poultry, fish with Livestock, fish with rice farming, fish with vegetables and crops where these two or three commodities are benefited by one another, particularly for the appropriate natural resource management without applying extra feed and fertilizer. Historically, fish farming has been a part-time activity of peasants, who developed it as an efficient means of utilizing farm resources to the maximum extent. For the role of integrated farming in augmenting the employment opportunity, nutrition and income of rural population, it has received considerable attention in recent years.

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Integrated farming system ensures the multipurpose use of land. The farming system studied here ensures the production of crops and fish from the same land at considerably reduced additional expense and with minimum adverse effects on crops and animal. Farm wastes are used for fertilizing and feeding the fish and sludge accumulated in the pond is used for fertilizing agricultural crops, vegetables and fruit trees grown around the pond. Basic principle involved in integrated farming is the utilization of the synergistic effects of inter-related farm activities providing beneficial impacts in the farm productivity. It is based on the concept that there is no waste and wastes are only a misplaced resource, which can become a valuable material for another product (Nuruzzaman, 1990).

In Bangladesh, *gher* farming technology was developed in the 1980s by the farmers in Bagerhat District. Since then *gher* farming has rapidly spread to Khulna, Jessore, Gopalganj and Satkhira districts, and the number of *ghers* increased by approximately 10-20 percent every year (Anon, 2000, 1998, 1996). In the 1990s, the adoption of *gher* farming had increased dramatically simply because the farmers saw their neighbors making lots of money from *gher* farming. The news about this technology quickly spread to neighboring areas and the so-called *gher* revolution had begun (Kendrick, 1994). Later on, because of high value, different components of prawn-agro *gher* farming viz., rice, fish (typically silver carp, catla, grass carp, prawn, etc.) and varieties of dike crops (fruits, vegetables and trees) were introduced into the system. In this system, pond-dikes support production of a wide range of crops, helping to reduce malnutrition and further it could be an important way to diversify livelihood and use valuable space more efficiently (Datta *et al*., 1998). According to Nabi and Ahmed (2001), the cropping system is essentially rotational since most farmers engaged in *gher* system grow only dry season rice with prawns and fish constituting the wet season crop.

The study was fully concentrated on the management system of various *gher* dike crops and on the institutional context for promoting *gher*-dike systems. The main objectives of the present study were to know the present status and problems of galda-agriculture *gher* farming system in the coastal areas of Bagerhat District and to analyze the impact of *gher* aquaculture on the livelihood of those farming households, to enhance the role of aquaculture ponds through improved and integrated management and to provide possible information for improvement.

Materials and Methods

***Selection of study area*:** The study on the integrated prawn-agriculture *gher* farming system was carried out in 20 farming households at Fakirhat Upazila of Bagerhat District. The *gher* owners were selected randomly.

***Data collection*:** A questionnaire was made for the survey. The duration of the survey was from August to October 2005. Information about the prawn-agriculture *gher* farming system was collected through interviewing the *gher* owners.

***Types of data collected*:** Data related to prawn-agriculture *gher* farming system was collected from direct observation. Data regarding the types of dike crops, vegetables, fruits and timber trees, cultivation period of various dike-crops with beneficial importance, amount of consumption or sale of the products in the market were collected through interview, and role of women and their participation in the productions, necessity of security were discussed. Information about the amount of production and their costs along with the income and benefit of the integrated farming of prawn with paddy in the raised bottom of the pond and different vegetables and fruits in the dike were also collected.

***Statistical analysis*:** Collected data were processed and analyzed by simple statistical tests, like measures of central tendency and dispersion.

Results

***Production of prawn and finfish*:** The survey revealed that in 0.5-3.0 ha *ghers* the production of prawn ranged from 240-1440 Kg and finfish (rohu, catla, silver carp, grass carp, Thai puti) ranged from 320-900 Kg, which were sold in the markets at Tk 84,000-504,000 for prawn and Tk 19200-54000 for finfish (Table 1).

Table 1. Range of production and sale price of prawn and finfish according to the size of the *ghers*.

Size of the *gher* (ha)	Production (Kg)		Sale Price (Tk)		Revenue (Tk ha^{-1})	
	Prawn	Finfish	Prawn (Tk 350 Kg^{-1})	Finfish (Tk 60 Kg-1)	Prawn	Finfish
0.5-1.0	240-510	320-600	84,000-1,78,500	19,200-36,000	167960-200070	34580-38285
>1.0-1.5	460-800	600-710	1,61,000-2,80,000	36,000-42,600	142025-222300	33345-39520
>1.5-3.0	800-1440	710-900	2,80,000-5,04,000	42,600-54,000	172900-230945	35815-44460

***Prawn culture with paddy and after harvest of paddy*:** In prawn with paddy culture system the production of prawn was 100-200 Kg ha^{-1} without using supplementary feed and where supplementary feed were used, the production went up to 200-400 Kg ha^{-1}. This farming system needed 6 months to complete a cycle (Table 2). On the other hand, in paddy-prawn sequential culture system, the production of prawn was expected to be 500 Kg ha^{-1} without using extra feed. This culture system needed 9-11 months to complete cycle (Table 2).

Table 2. Rice cropping pattern with and without prawn.

Cropping Pattern	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Simultaneous Culture	Rice-Prawn											
Sequential	Rice											
							Prawn					

Success of this type of paddy-prawn-fish culture depends on the proper selection of suitable fish and rice varieties, both of which must be able to withstand a great deal of fluctuation of water level and environmental conditions.

Average per hectare production cost and return in prawn-paddy *gher* farming system are presented in Table 3. Some more benefits were experienced from prawn after paddy *gher* farming system as the duration of this culture system (9-11 months) was longer than that of prawn with paddy culture system (6 months).

Table 3. Production cost and return (per hectare) in prawn-paddy *gher* farming system.

Items	Prawn with Paddy		Prawn after Paddy	
	Cost (Tk)	Income (Tk)	Cost (Tk)	Income (Tk)
Preparation of land	610		510	
Ploughing & fertilization	4,148		4,148	
Paddy culture	7,900	30,800	8,250	30,800
Prawn culture	15,500	23,000	22,350	50,000
Others	2,372		4,835	
Total	33,405	53,800	45,343	80,800
Net Profit	53,800-33,405 = 20,395		80,800-45,343 = 35,457	

***Integrated prawn farming with vegetables and fruit trees*:** 20 different vegetables and four different fruit trees were found to be cultivated in the survey area as integrated prawn-

vegetable/fruit *gher* farming system. Their culture period, production and sale price are presented in Table 4. Production cost of this dike cropping mentioned by the *gher* owners was more or less Tk 1200 ha^{-1} and the return was around Tk 3000 ha^{-1} along with a net profit Tk 1800 ha^{-1} approximately.

The survey showed that in the studied area all of the vegetables were not equally beneficial for integrated farming. According to the *gher* owners the integration of bitter gourd and okra were more beneficial as vegetables and banana as fruit.

Table 4. Time table for cropping of various vegetables and fruits along with their production and income.

Types of Vegetables	Culture Duration (in months) J	F	M	A	M	J	J	A	S	O	N	D	Production (Kg ha^{-1})	Rate (Tk Kg-1)	Sale Price (Tk)
Red amaranth (*Lal shak*)													8	4	32
Spinach (*Palang shak*)													3	5	15
Green amaranth (*Puishak*)													9	4	36
Bean (*Sheem*)													15	8	120
Okra (*Dheros*)													12	12	144
Snake gourd (*Chichinga*)													15	10	150
Bitter gourd (*Karolla*)													20	12	240
Turnip (*Salgom*)													7	10	70
Cauliflower (*Fulcopi*)													10	8	80
Cabbage (*Badhacopi*)													9	12	108
Radish (*Mula*)													5	4	20
Brinjal (*Begun*)													12	12	144
Green peas *(Motor shuti*)													1	15	15
Green chilies (*Mowrich*)													2	20	40
Tomato (*Tomato*)													10	8	80
Gourd (*Lau*)													15*	10**	150
Pumpkin (*Kumra*)													12*	20**	240
Cucumber (*Shawsa*)													9	12	104
Ridge gourd (*Jhinga*)													4	8	32
Long bean (*Barbati*)													6	8	48
Types of fruits	J	F	M	A	M	J	J	A	S	O	N	D			
Banana (*Kala*)													300*	2**	600
Papaw (*Paypay*)													25	4	200
Date (*Khejur*)													3	5	15
Coconut (*Narkel*)													30*	7**	210

* piece, ** per piece

***Cost-benefit analysis*:** Cost-benefit analysis in one cycle of production for 100 decimal *gher* is shown in this section. Total production of such a *gher* in single cycle was 240 Kg prawn, 320 Kg fin fishes, 150 Kg vegetables, and fruits worth of 750 Tk (Table 6). Total production cost was 44,180 Tk (Table 5) and the return was 104,850 Tk (Table 6). According to Table 5 and Table 6, the net profit was calculated to be 51,420 Tk [(104,850 Tk – 9,250 Tk) – 44,180 Tk], which is equivalent to Tk 127,000 ha^{-1}.

Table 5. Production cost per cycle in a 100 decimal *gher*.

Activity	Items	Amount or No.	Rate (Tk)	Cost (Tk)
	Dike and *gher* repairing	-	-	850
Pond	Rotenone	1 Kg	260	260
Preparation	Lime	90 Kg	8	720
	Fertilizer	40 Kg	20	800
Stocking	Prawn (PL + Juvenile)	3000 + 4000	1.5+2.5	14500

	Finfish (Catla+Silver carp+Grass carp+Rohu+Punti)	180+750+100 +400+750	3+2+1 +2+1	3590
Feeding		350 Kg	10	3500
Dike Crops	Banana + Papaw	10 + 20	-	220
	Vegetable seeds	-	-	40
	Labor + Night guard	2 + 1 man	5000	15000
	Harvesting	-	-	1200
	Transportation	-	-	1,500
	Miscellaneous	-	-	2,000
	Total			44,180

Table 6. Production and total income of a 100 decimal *gher*.

Items	Amount (Kg)	Price (Tk Kg^{-1})	Total Income (Tk)	Family consumption	
				Kg	Tk
Prawn	240	350	84,000	10	3,500
Fin fishes	320	60	19,200	75	4,500
Vegetables	150	6	900	125	750
Fruits			750		500
Total			104,850		9,250

Discussion

Different types of integrated prawn-agriculture *gher* farming systems were practiced in the survey area like prawn with paddy/ prawn with vegetables/ prawn with fruits and wood trees/prawn with finfish or integrated prawn farming with all the above commodities. These were found to be practiced with different degrees of management, so the production and net income from these integrated farming varied from farm to farm.

***Integrated rice-prawn farming*:** The culture of fish in rice fields has been practiced in Asia for many centuries. Now a day it is very common in Southeast Asia. It is a traditional practice especially in the low land areas where the depth of water is relatively hi*gher*. Recently in Bangladesh this kind of practice is carried out in large number of areas in the Southwest region like Bagerhat, Satkhira, Khulna etc. Rice-prawn-fish culture in Fakirhat Thana of Bagerhat District was found to be as an indigenous technique developed solely by the local farmers.

The *gher* systems of Southwestern Bangladesh are characterized by digging of trenches that occupy up to half the area of rice fields, and dikes with areas much greater than those seen in typical rice-fish fields. Wild post larvae were stocked directly into rice fields at high densities (usually 0.5 to 2.0 PL m^{-2}) at the beginning of the wet season from late April to May. According to Ahmed (2004), the rich supply of plant nutrients in the rice fields promotes the luxurious growth of weeds and algae with the rice plants. These support a large population of crustaceans, rotifers, worms and insect larvae, which make wonderful fish foods.

There were two types of prawn-paddy farming - simultaneous culture and sequential culture. For these culture systems Boro and Aman paddy fields having water all the year round were mainly used.

***Simultaneous paddy-prawn farming*:** After land preparation with ploughing and fertilization paddy was planted in the field and after 20-25 days PL of prawn were stocked. Normally no extra feed was used for prawn because the weeds, insect larvae and various particulate materials of paddy fields were used as feed for the prawn in controlling these rice pests and reduces competition with paddy for nutrition and space. Similarly the faeces of prawn and various decomposed materials were used as fertilizer for the paddy, which reduces the production cost of these two commodities. Primarily the depth of water in the field was maintained 10-15 cm.

***Sequential paddy-prawn farming*:** In this system paddy and prawn were grown in the same land in sequence. After land preparation paddy was first cultivated as it is done in prawn-paddy simultaneous culture system. But in this case, the production cost was higher than the above system because in this system two products were cultured separately and for paddy culture fertilizer was used. In this system crop residues after paddy harvest was not uprooted, which on decomposition supplied feed for prawn.

***Management system of the dike crops*:** In recent years, vegetable cultivation on *gher* dikes became popular in this region. Many farmers now grow vegetables all the year round. Farms having wide dikes have greater opportunity to grow more vegetables. Narrow dikes can still be used to grow vine type vegetables up trellises inside the *gher*. Growing vegetables is of low risk and requires little capital investment. It enhances food security for the family and income from the sale of the surplus crops can be used to finance feeding prawns, repair of the *gher*, loan repayments and input requirements in the following year (William and Khan, 2002). Farmers earn around Tk 9000 ha^{-1} from selling their vegetables which represents around 8% of the annual income from the *gher* (Abedin *et al.*, 2001).

Before plantation of various dike crops, every year the *gher* owners reconstruct their *gher* dike. For this they first dig out the bottom mud of the *gher* and use this mud for the construction of the *gher* dike. Bottom mud act as fertilizer for the dike crops which save the production cost with respect to fertilization for cultivation of the crops (Ahmed, 2004). After preparing the dike properly, the seeds of various vegetables, fruits and wood trees were planted in and around the dikes. The household women played a vital role in looking after these crops. Local people also believe that women participation has reduced the number of women migrating out of the area into the garment and fish/prawn processing factories in the cities (Kendrick, 1994).

The dike crops were found to be cultivated subsequently according to two main cropping season viz., *rabi* (winter season) and *kharip* (summer season). Some fruit trees like coconut and date were planted as permanent fruit trees. Various dike crops like jhinga, bean, lau, shawsa, pui shak, chichinga, kumra etc. were grown on macha or bera (bamboo-made support structure) for their protection. Some inorganic fertilizers were applied informally for vegetables and fruit trees. Harvested dike crops used to be consumed in the family, given to the relatives and sometimes sold in the markets. If the dikes of *ghers* are properly utilized for the cultivation of various vegetables and fruits then it will at least meet the family demand. Dikes of most of the survey *ghers* were not cultivated commercially. If they cultivate these dike crops commercially then it will also meet their local demand and become a source of income that will help to improve their livelihood pattern.

Conclusion

Integrated prawn-agriculture *gher* farming can be highly beneficial for the farmers of the country like Bangladesh, because in this culture system, more than two commodities are produced in the same area through using land and water in maximum level and the production cost can be significantly reduced. If this farming system can be adopted all over the country, yield of agro-fisheries products can be increased significantly to make better contribution in national economy. For this, development within the general agricultural system, intensive support from institutional players is crucial to help both producers and consumers of the country. The success of this integrated approach largely depend on the combination of local expertise, scientific know-how, and the understanding of social, cultural, ecological, economical and political will. A well-planned and realistic approach is a must for successful integrated farming.

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