Economic Evaluation of Rice-Prawn Gher Farming System on Soil Fertility for Modern Variety (MV) Paddy Production in Bangladesh

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Abstract

This present study attempts to examine the economic evaluation of rice-prawn gher farming system on land fertility for modern variety (MV) paddy production in Bangladesh. Laboratory based experimental data and field survey data were used in the present study. To test the change of land fertility, soils were collected before paddy production (after prawn production) and after paddy production (before prawn production) and tested in the Soil Resource Development Institute (SRDI) laboratory in Khulna, Bangladesh. The findings of the study indicate that the farmer applied comparatively less chemical fertilizers in MV paddy production under the rice-prawn gher farming system compared to MV paddy production. The input cost of chemical fertilizers for MV paddy farming was about six times higher than MV paddy production under the rice-prawn gher farming system. However, per acre MV paddy production of MV paddy farming was almost same to MV paddy production under the rice-prawn gher farming system. The rice-prawn gher farming is a cost-saving technology for MV paddy production.

JEL classification: O13, Q55

Keywords: Rice-prawn gher farming system, Soil fertility, MV paddy production

1. Introduction

Rapid population growth, increased food demand, and urbanization are the main causes that place tremendous pressure on agricultural land, making it an increasingly scarce resource (Bhuiyan, 2001). As a result, agricultural land per capita is decreasing over the years in Bangladesh (Alexander et al., 1998; Akteruzzaman, 1998). Food insecurity is a critical concern since the independence of Bangladesh. Despite a

noticeable improvement in paddy production in recent years still falls short of attainable levels. The government of Bangladesh imports a large amount of rice from aboard to meet up the domestic demand (Zaman, 2001). Proper cropping intensity and management with high yielding modern varieties (MV) of paddy production is the logical way to raise the total production to meet up the domestic demand of food using limited land resources (Islam, et al., 2002).

The rice-prawn gher farming system that locally known as "*gher revolution"*, (Kendrick, 1994) diffused rapidly compared to green revolution in Bangladesh, mainly because of indigenous natural resources used at the early stage (Barmon et al, 2005). This farming has positive impacts on labor market and increased daily labor wage compared to MV *boro* and local *aman* paddy (Barmon et al., 2004). The agricultural and household income of rice-prawn gher farmers are more than seventeen and two times higher compared to MV and local *aman* paddy farmers (Barmon et al., 2004a, 2004b). The shrimp gher farming has negative impacts on environments and ecology in the coastal region in Bangladesh (Asaduzamman et al., 1998; Nijera Kori 1996; and Sobhan, 1997; Bhattacharya et al. 1999; Datta, 2001), whereas the impact of rice prawn gher farming on the environment is ambiguous. Ali (2004) conducted a research of the impact of the cultivation of high yielding variety (HYV) rice using modern inputs such as power tillers, low-left irrigation pumps, chemical fertilizers and pesticides on soil qualities and land degradation during the period 1985-2000 in a village in southwestern Bangladesh and his research concluded that the modern inputs especially the chemical fertilizers and pesticides have negative impacts on soil quality and land degradation. However, the impacts of rice-prawn gher farming system on soil fertility for MV paddy production in the southwest Bangladesh have been paid less attention. Therefore, the

present study evaluates the economic impacts of rice-prawn gher farming system on land fertility for MV paddy production.

2. Methodology of the Study

The present research was conducted at Bilpabla village in Khulna district of Bangladesh in order to assess the impacts of rice-prawn gher farming system on soil fertile for MV paddy production (Figure 1).

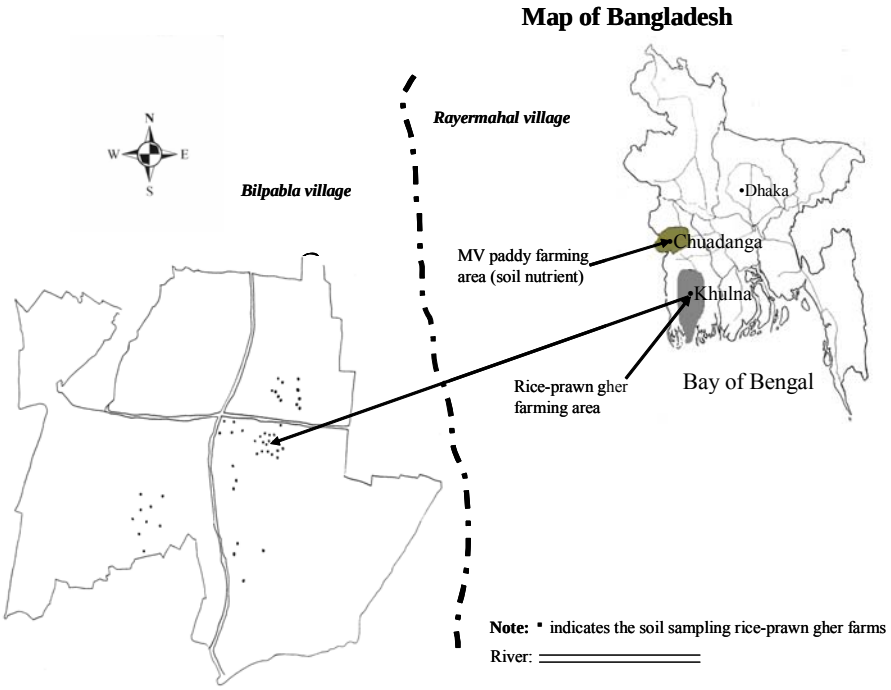


Figure 1. Rice-prawn gher farming area (study area)

The soil samples utilized for the research were taken from 50 gher plots of 32 gher farmers in different locations where the farmers cultivated paddy in 2004. The soils were collected before (after prawn production) and after the MV paddy production. The National Soil Resource Development Institute (SRDI) of Bangladesh developed standard laboratory to determine the major soil nutrients such as nitrogen (N), potash

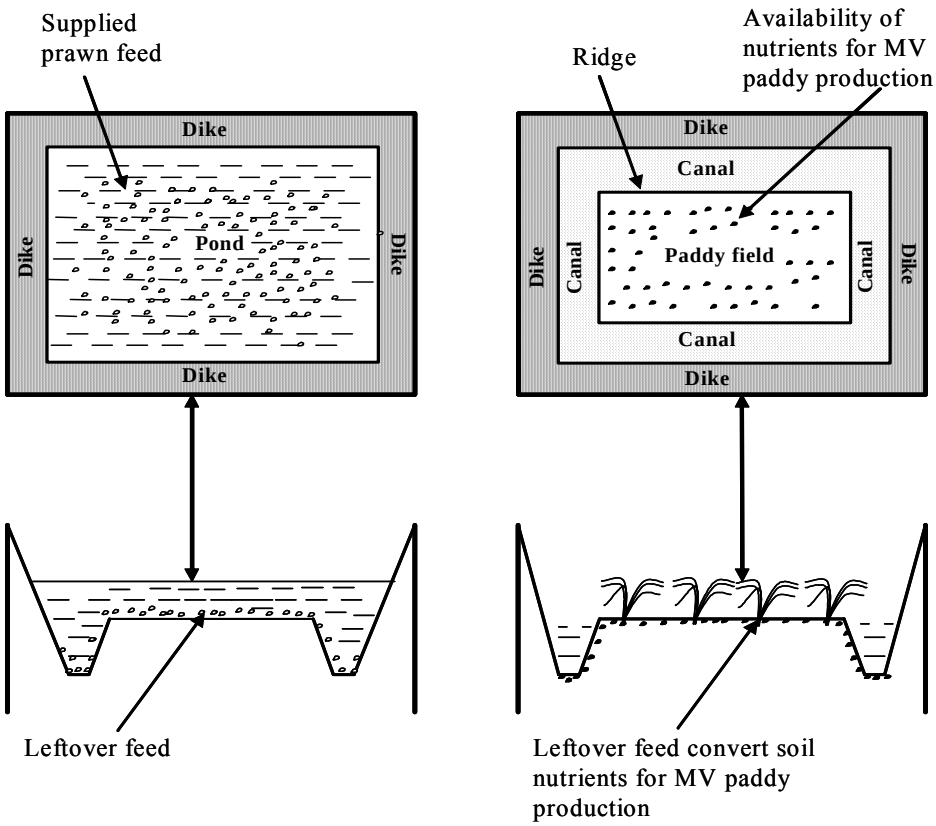
(K), phosphorus (P), calcium (Ca), zinc (Zn), sulpher (S), manganese (Mn), boron (B) and copper (Cu) that directly affect the paddy production.

The present study also conducted a cross-sectional field survey on MV paddy production at Chanchra village in Jessore district (neighboring district of Khulna) where the farmers mainly produce MV paddy twice a year. Thirty-three farmers were randomly selected and collected necessary information for MV paddy production.

3. Rice-prawn Gher Farming System in Bangladesh

In Bangladesh, two types of gher farming are operated; one is brackish water based shrimp culture and another is fresh water based rice-prawn culture. Shrimp gher farming is large in size and scale, and needs saline water, whereas prawn gher farming is comparatively small in size and scale, and need fresh water.

The term *Rice-prawn gher* refers to a modification of paddy field that has been used for prawn and paddy cultivation. The main land (locally known as *Chatal*) of gher is surrounded by high wide dikes and canals that lies the periphery of the dikes (Figure 2). The whole land of gher is filled up with rain-water from June to December and resemble to a pond. During this time, farmers cultivate prawn (*Macrobrachium rosenbergii*) and carp fishes. The entire land becomes dry naturally from January to April except canals. The canals retain sufficient water for MV *boro* paddy during this time. As a result, farmers can grow MV *boro* paddy on *chatal*. Moreover, farmers grow vegetables on the dikes throughout the year.



a) Gher farming in rainy season b) Gher farming in winter season

Figure 2. Diagram of rice-prawn gher farming system and soil fertility process for MV paddy production.

During the growth period, the farmers give various types of supplementary feed to the prawn. The farmers use three types of supplementary feed: processed feed, homemade feed and meat of mud snail. The ingredients of homemade feed includes oil cakes, polished rice, molasses, wheat bran, wheat, fishmeal and other feeds in fixed proportions.

Some farmers also use oil cake, wheat bran, and boiled rice directly without mixing. The meat of mud snails is commonly used as prawn feed. The farmers provide these feeds during the whole cycle of prawn production. The prawn and carp fish do not

eat completely these supplied feed. The leftover feed makes the paddy field fertile and the paddy crop is able to take necessary nutrients from the fertile field.

There is no standard feeding system in rice-prawn gher farming system in Bangladesh. Usually the farmers apply trial-and-error technique as feeding system in prawn production. At the early stage of the rice-prawn gher farming system, the farmers mainly used meat of mud snails as prawn feed for optimal production which collects from rivers and swamplands. But at present, mud snails are unavailable in swampland and rivers, and most of the mud snails are imported from nearby districts as well as India. Moreover, the price of mud snails has increased significantly due to the high demand for prawn feed over the years. As a result, farmers use supplementary feed differently depending on their experience and the practices they employ. Descriptive statistics of prawn feed per acre, prawn fingerlings and carp fish are presented in table 1.

Table 1. Descriptve statistics of per acre feed, fingerlings of prawn and carp fishes under rice-prawn gher farming, 2004

Type of feeds	Mean	Standard Deviation	Minimum	Maximum	Used numbers of gher plots
			Fingerlings		
Prawn fingerlings (Nos)	8,868	2,933.00	300	16,000.0	50
Fish fingerlings (Kgs)	14	11.67	0	50.0	49
			Feeds		
Mud Snail (Kgs)	702	613.30	0	2,400.0	45
Fish meal (Kgs)	232	205.30	0	900.0	42
Pulses (Kgs)	112	127.70	0	450.0	31
Cooked rice (Kgs)	29	71.80	0	400.0	15
Oilcake (Kgs)	48	70.34	0	250.0	30
Chira (Kgs)	33	64.10	0	360.0	38
Wheat bran (Kgs)	220	237.10	0	840.0	38
Others (Kgs)	122	379.30	2	2,642.4	50

Source: Field survey, 2004

4. Results and Discussions

4.1 Impacts of Gher Farming on Soil Nutrients

The agricultural land of Bangladesh is not uniquely fertile due to soil textures, location, presence or absence of flood, drainage or irrigation facilities as well as intensive cropping patterns. A number of studies have claimed that agricultural land has degraded due to unbalanced application of these chemical fertilizers and intensive mono-culture MV paddy production in Asia (Pingali and Rosegrant, 1994; Ipe, 1995; Alexander, et.al 1998; Islam and Weil 2000; Bhuiyan, 2001; and Ali, 2004). In Bangladesh, plant nutrient in soil that naturally endows or artificially maintain is the main success or failure of a crop production system. Cropping patterns, the integrated plant nutrient system (IPNS) (Bhuiyan, 2001) and nutrient management are the most efficient ways for getting a higher yield (Islam et. al., 2000), which increase higher nutrient use as well as maintains the healthy condition of soil (Ehui and Spencer, 1993).

The rice-prawn gher farming system is an IPNS, combination of aquaculture and agriculture, has significant impacts on soil nutrients, helping to make the land fertile for MV paddy production after prawn production. The impacts of rice-prawn gher farming on soil nutrients are presented in table 2. It appears from the table that all experimental micro and macro nutrients of soil has decreased after paddy production, however, the quantity of all soil nutrients before paddy production (after prawn production) and after paddy production (before prawn production) are higher than the experimented soil nutrients of MV paddy production in Chuadanga district of Bangladesh (Duxbury, 2001). The availability of all sampled micro and macro nutrients also significantly varies among the sample plots before and after the prawn production because of various combinations of feed application during prawn production. Therefore, it can be

concluded from the table 2 that the rice-prawn gher farming system has significant impact on soil fertility for MV paddy production.

Table 2. Descriptive statistics of soil fertility status (0-15cm) in rice-prawn gher farming system in Khulna district, Bangladesh

Particulars	Rice-prawn Gher Farming							
	Before paddy production				After paddy production			
	Mean	SD	Min	Max	Mean	SD	Min	Max
pH	7.69	0.746	5.0	9.1	7.05	0.424	6.2	7.9
Total Nitrogen (N%)	0.46	0.118	0.29	0.75	0.37	0.102	0.19	0.61
				mg/100g soil				
Potash (K)	1.25	0.403	0.62	2.89	0.97	0.23	0.61	1.60
Calcium (Ca)	29.9	6.41	16.25	49.05	23.23	4.33	14.75	32.75
				µg/g soil				
Phosphorus (P)	12.23	7.73	2.26	37.00	9.56	5.89	2.16	34.00
Zinc (Zn)	2.17	1.09	0.80	6.8	1.59	0.937	0.60	5.82
Sulpher (S)	232.5	95.1	49.1	410.6	176.2	80.4	49.1	381.6
Manganese (Mn)	108.48	38.2	39.4	212.0	88.24	22.5	50.0	173.6
Boron (B)	2.87	0.655	1.75	4.23	2.05	0.549	1.12	3.51
Copper (Cu)	12.54	3.71	5.42	21.81	10.64	2.11	4.42	14.42

Source: Laboratory experiement, 2005.

Notes: 1) Soil sample size was 50 from 32 gher farmers.

2) SD indicates standard deviation.

4.2 Application Chemical Fertilizer for MV Paddy Production

Chemical fertilizers such as urea, triple super phosphate (TSP), muriate of potash (MP), gypsum, and zinc sulfate are commonly used in MV of paddy production in Bangladesh. Usually the farmers do not use any chemical fertilizers except homestead manure and cow dung for local *aus* and *aman* paddy production. However, the farmers apply various types of chemical fertilizer for MV *aman* and *boro* paddy production. Application of chemical fertilizers for MV production and MV paddy production under rice-prawn gher farming system are exhibited in table 3.

Table 3. Per acre chemical fertilizer use in MV paddy production and MV paddy production

Farming System	Application of chemical fertilizers						Paddy production (Mound)
	Urea (Kg)	TSP (Kg)	MP (Kg)	Zypsum (Kg)	Irrigation (No.)	Pesticides (No.)	
Paddy production under gher farming (GF)	21.79	15.54	3.43	4.62	4.32	2	43.1
MV Paddy farming (PF)	99.54	76.6	33.22	83.7	6	2	49.89
Ratio (PF/GF)	4.57	4.93	9.69	18.12	1.39	1.00	1.16
t-ratio	8.61*	5.39*	6.53*	7.64*	Na	Na	3.26*

Source: Field survey, 2005.

Notes: 1) TSP and MP indicate Triple super phosphate and Muriate of potash, respectively.

2) One mound equivalent to about 40 kgs.

3) * 1% level of significance.

4) Sample size of gher, and MV paddy farming were 32 and 33, respectively.

The figures in the table shows that the farmers apply, on an average, 99.5 Kg of urea, 76.6 Kg of TSP, 33.2 Kg of MP, and 83.7 Kg of gypsum per acre MV paddy production, and only 21.8 Kg of urea, 15.5 Kg of TSP, 3.4 Kg of MP, and 4.6 Kg of gypsum per acre MV paddy production under rice-prawn gher farming system. In other words, the farmers use more chemical fertilizers in MV paddy production compared to MV paddy production under rice-prawn gher farming system and the application rates of all chemical fertilizers in per acre paddy production are significantly differ from farmers to each other. The main reason is that the leftover feed during prawn production makes the paddy field fertile and the paddy crop takes necessary nutrients from the fertile field. In addition to this, some aquatic habitats are grown during the prawn production and these aquatic habitats are used as composed manure to paddy production under gher farming system. Therefore, it can be assumed that the leftover feeds and the aquatic habitats make the soil fertile that reduce the application of chemical fertilizers in MV paddy production under rice-prawn gher farming system.

Paddy production per acre of two agricultural systems is also presented in table 3.

The figure in the table indicates that production per acre (about 50 mounds) of MV paddy farming is higher that MV paddy production (about 43 mounds) under rice-prawn gher farming system. One of the main reason is that the gher farmers are not serious about paddy production like prawn production because paddy is not profitable crop like prawn production. The farmers mainly produce paddy for home consumption.

4.3 Comparison of Chemical Fertilizers Cost between two Agricultural Production Systems

Input cost per acre of chemical fertilizers for MV paddy production under rice-prawn gher farming system and MV paddy farming is presented in table 4 and shown that cost for chemical fertilizers of MV paddy farming per acre is Taka 2,231 and only Taka 356 for MV paddy production under the gher farming system, indicating the input cost of chemical fertilizers for traditional MV paddy farming is about six times higher compared to MV paddy production under rice-prawn gher farming system.

Table 4. Comparison of per acre cost of chemical fertilizers between rice-prawn gher and MV paddy farming

Farming System	Application of chemical fertilizers				Total cost (Taka)	Ratio (PF/GF)
	Urea (Taka)	TSP (Taka)	MP (Taka)	Zypsum (Taka)		
Paddy production under gher farming (GF)	125	172	30	29	356	6.27
MV paddy farming (PF)	570	849	293	519	2,231	

Source: Gateway to Fertilizer Information in Bangladesh, 2005.

Notes: 1) TSP and MP indicate Triple super phosphate and Muriate of potash, respectively.

2) Retail price of per Kg Urea, TSP, MP and zypsum is Tk 5.73, Tk 11.08, Tk 8.82 and Tk 6.2, respectively.

3) Sample size of gher, and MV paddy farming were 32 and 33, respectively.

4) 1$US= Taka 72.73, March, 2006.

Therefore, it may be concluded that the locally adopted rice-prawn gher farming technology has significant impacts on soil nutrients for MV paddy production. In other words, this farming system has reduced the production cost system for MV paddy

production compared to MV paddy production in Bangladesh.

5. Conclusions

The rice-prawn gher farming system is an indigenous agricultural system solely developed by farmers since mid 1980s. The rice-prawn gher farming system has significant impacts on soil fertility for MV paddy production. The farmers apply comparatively less chemical fertilizers in MV paddy production under the rice-prawn gher farming system compared to MV paddy production in Bangladesh and are statistically significant between the two agricultural systems. Input cost per acre of chemical fertilizers for MV paddy production is about six times higher than MV paddy production under rice-prawn gher farming technology. However, production per acre of traditional MV paddy farming is almost same to MV paddy production under the rice-prawn gher farming system. Therefore, it can be concluded that rice-prawn gher farming system is a cost-saving technology for MV paddy production.

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