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Local Technology Adoption and Its Diffusion Process: Evidence from the Rice-Prawn Gher Farming System of Bangladesh

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1. Introduction

The term *rice-prawn gher* refers to a modification of paddy field that has been used for prawn and paddy cultivation. The mid field (locally known as *Chatal*) of *gher* is surrounded by high wide dikes and canals that lies the periphery of the dikes. 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. The entire land becomes dry naturally from January to April except canals. The canals retain water sufficient water for modern variety (MV) *boro* paddy during this time. As a result, farmers can grow MV *boro* paddy[1] on *chatal*. Moreover, farmers grow vegetables on the dikes throughout the year.

Before introducing the gher farming system, the southwest of Bangladesh was waterlogged and suffering from increased saline intrusion and siltation of rivers and canals due to construction of embankments and polders. Farmers could not produce any additional agricultural crops and sometimes produced local varieties of *aus* or *aman* paddy once in a year. After the introduction of gher farming, farmers could produce MV *boro* paddy that was not possible in the past. Farmers irrigate the paddy field from canals using indigenous handmade tools such as *doone* and baskets. The gher farmers use a small amount of chemical fertilizer for MV *boro* paddy production. The introduction of rice-prawn gher farming in southwest Bangladesh is locally known as *Gher Revolution* (Kendrick, [7]).

There are a few studies that focus on the impacts of rice-prawn gher farming on labor demand (Barmon et al. [2]) and household (Barmon et al. [3]), and the impact of shrimp gher farming on the environment (Asaduzamman et al. [1]; Nijera Kori [8]; and Bhattacharya et al [4]) and ecology (Datta [8]) in the coastal region of Bangladesh. However, there is no study on the factors behind the rapid diffusion of rice-prawn gher farming. Therefore, the present study explores the factors behind the rapid diffusion of rice-prawn gher farming in the southwest Bangladesh.

2. Methodology of the study

The present study was conducted at Bilpabla village in Khulna district because the farmers of this village have good experience with rice-prawn production. Primary data used in the present study were collected through a comprehensive cross-sectional field survey in November 2004.

The first introducer, two landlords (one is from Bilpabla village and another is from nearby Rayermahal village) and two tenants were interviewed.

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1 Rice is cultivated in Bangladesh throughout the year as *Aus*, *Aman* or *Boro*. *Aman* (broadcast and transplanted) is generally cultivated in December-January, *Boro* in March-May and *Aus* in July-August cropping seasons.

There are only three landlords in Bilpabla village. The selected landlord in Bilpabla village has a comparatively large scale of gher land (26 bigha; one bigha is equal to 0.5 acre or 0.2 hectare in the locality) compared to the other two landlords. Before the introduction of gher farming in Bilpabla village, the selected landlord cultivated 64 bigha local paddy of which 14 bigha was his own and another 50 rented on a sharecropping basis. He bought another 12 bigha gher land after in the introduction of gher farming. The other two landlords rented out only 5 bigha and 4 bigha of gher land.

On the other hand, the selected landlord of Rayermahal village holds about 88 bigha gher lands. Before the gher farming started, he rented out almost the same amount of farmland to several sharecroppers. He is a landlord by ancestry.

The tenants were also purposively selected (see table 2) - one from Bilpabla village and another from Rayermahal village because these two tenants have rented gher farm from the selected landlord of Bilpabla village. The tenant who lives in Bilpabla village bought 2.0 bigha gher farms in 1998 and has cultivated since 1998. However, he sold this land to a landlord in 2001 and rented the same land in 2001. In other words, there were in landownership from landowner to tenant. On the other hand, the tenant who lives in Rayermahal village rented land from a landlord of Bilpabla village in 2000. Before 2000, there was a different tenant operated this plot of gher.

3. Factors influencing rapid diffusion process of rice-prawn gher farming

A number of factors interact to influence the rapid diffusion process of rice-prawn gher farming. The introducer, selected landlords, and tenants have explained some factors that accelerated the rapid diffusion of rice-prawn gher farming in the study village as follows:

3.1 Indigenous natural resources and price of inputs and output

At the early stage, farmers intensively used natural indigenous inputs for gher farming operation. Farmers collected prawn fingerlings from sea and rivers, and mud snails which are the main feed for prawn production from swamplands, rivers and canals. As the prawn fingerlings and feed were indigenous natural inputs, the market price of the inputs was low.

However, different pictures have been found in the case of MV paddy production in Bangladesh. Byerlee [5] argued that farmers of developing countries have struggled with indecision at the early stage of any agricultural technological progress and innovation for agricultural development. Further evidence has shown that at the early stage of the green revolution in Bangladesh, the farmers struggled with indecision to cultivate MV paddy due to insufficient knowledge about using chemical fertilizer, unavailable of irrigation system, and taste of rice, which served as the main criteria in farmer decision-making process (Field survey, 2004). In addition to these, the farmers depend on government and private organization for irrigation facilities and equipment, chemical fertilizers, etc.

The input and output prices have increased rapidly over the period. The price and relative prices of main inputs of rice-prawn gher farming are presented in Table 1. The figures in Table 1 show that price and relative prices of mud snails and prawn fingerlings have increased over the time. The relative price of fingerlings has increased more than four times, whereas the relative price has only doubled for mud snails. In other words, the relative price of prawn fingerlings has more than doubled in comparison to mud snails. The main reason is that the farmers substituted fishmeal and homemade feeds for mud snails. In

addition, the farmers import mud snails from neighboring districts and India due to unavailability in the local area. On the other hand, prawn fingerlings have no substitution in the gher farming system. Recently, the commercial hatchery farms have been producing prawn fingerlings but the mortality rate is higher than for the prawn fingerlings of sea and rivers.

Table 1. Changes in real prices of main inputs and land rent of rice-prawn gher farming system from 1990 to 2004

Particulars	1990		2004		Ratio of relative price
	Price (Taka)	Relative price	Price (Taka)	Relative price	
Prawn fingerling /thousand	250	1.25	2,500	5.56	4.5
Mud snail/kg	2.50	0.01	7.50	0.02	2.0
Land rent/bigha	2,000	10	6,000	13.33	1.3
Prwan/kg	200		450		

Source : Field survey, 2004.

Notes: 1) 1US$ = 65.85 Taka, November, 2005.

2) One bigha is equivalent to about 0.5 acre or 0.2 hectare in the locality.

3) Relative prices are calculated by dividing the input prices by prawn price. The output price of per kg prawn was Taka 200 in 1990 and Taka 450 in 2004.

3.2 Profitable enterprise

As mentioned earlier, the farmers could produce local varieties of *aus* and *aman* paddy once a year. But the farmers are producing MV paddy after prawn production in the gher farming system. In addition, the rice prawn gher farming system is a more profitable enterprise compared to local *aus* and *aman* production (Barmon, el al, [3]). As a result, the farmers quickly responded and converted their paddy field into gher farming.

3.3 Participation of landless and marginal farmers

At the early stage of rice-prawn gher farming in the study area, only a few rich traders and businessmen cultured prawn using permanent hired laborers. They were fully dependent on permanent hired laborers because they engaged in their main business and let permanent hired laborer operated the gher farming. The gher owners had no time to monitor the gher farming or sometimes they visited the gher farming once or twice a week in the daytime only. For first several years they earned a good profit because of low input costs such as feed costs and fingerling costs, and proper gher management as well as the integrity of hired labor. But within several years the permanent hired laborers began disruption of prawn production at every step of gher farming, for example, the permanent hired laborers did not use mud snails for prawn feeds instead they sold them to other farmers secretly or poached prawn from gher at night. Sometimes the owners increased their wage but they could not prevent these disruptive actions by the hired laborers. As a result, the gher farmers were losing simply due to lack of integrity of permanent hired laborers and exited from the gher farming a few year after the introduction of gher farming. The landlords operate only a small portion of their total farmlands for family home consumption and entertainment of relatives, and the rest of the farmland is rented out to several tenants on a fixed-rent basis (Table 2). The landlords

earn a handsome assured amount of income (land rent) for renting out of gher land annually.

Table 2. Renting out of landlords' land, number of tenants and duration of tenancy

Gher	Tenant	Living place	Land (Bigha)	Rent* (Taka)	Year 1992 93 94 95 96 97 98 99 00 01 02 03 04
					Landlord-1 (Bilpabla village)
Gher-1	T1	Rayermahal	1.5	4,500	
Gher-2	T2	Bilpabla	1.0	4,500	
Gher-3	T3	Bilpabla	2.0	4,500	
	T4 ○				
Gher-4	T5	Rayermahal	3.0	5,000	
	T6 ○				
Gher-5	T7	Bilpabla	1.5	5,000	
Gher-6	T8	Bilpabla	1.5	5,000	
Gher-7	T9	Bilpabla	2.0	4,500	
Gher-8	T10	Bilpabla	1.5	5,000	
		Total Rent		66,750	
					Landlord-2 (Rayermahal village)
Gher-1	T1	Rayermahal	10.0	5,000	
Gher-2	T2	Bilpabla	4.0	5,000	
Gher-3	T3	Bilpabla	6.0	4,000	
	T4				
Gher-4	T5	Rayermahal	6.0	4,500	
	T6				
Gher-5	T7	Bilpabla	4.0	5,000	
Gher-6	T8	Bilpabla	10.0	5,000	
Gher-7	T9	Rayermahal	10.0	5,000	
Gher-8	T10	Rayermahal	10.0	5,000	
	T11				
Gher-9	T12	Bilpabla	4.0	4,500	
Gher-10	T13	Rayermahal	6.0	5,000	
		Total Rent		339,000	

Source: Field survey, 2004.

Notes: 1) T indicate tenant.

2) ⟷ indicate duration of tenant.

3) ○ indicates tenants were interviewed.

4) 1 US$ =65.85 Taka, November, 2005.

5) * Land rent per bigha in 2003.

This incidence opened the door for poor landless and marginal farmers to enter into the gher farming. The landless and marginal farmers always monitored and operated the gher farming by themselves, and as a result more income was being generated from gher farming. Thus, gher farming made these farmers financially solvent. The success of gher farming influenced other farmers to rent land from landlords and converted their paddy fields into gher farming along with the landowners. This expanding process occurred from 1990 to 1997 (Figure 1). As a result, gher farming expanded rapidly mainly due to the huge amount of landless and marginal farmers' participation.

3.4 Land rent of gher farm

The institutional change of the land tenancy market also influenced the landless and marginal farmers to participate in gher farming. The land tenurial arrangement changed from a traditional sharecropping system to fixed rent after the introduction of gher farming. The monitoring cost and production risks were significantly higher in comparison to traditional paddy production. Moreover, the main outputs (prawn and fish) of gher farming are not observable like paddy farming. Both parties of the tenurial arrangement can not predict the production of prawn like paddy production because the prawn production depends on the mortality rate of fingerlings and unknown virus diseases. Moreover, the landlords received a fixed amount of income from renting out gher lands which was not possible before gher farming. On the other hand, the landless and marginal farmers manage the gher farm properly for optimal production and earn more money after paying the land rent. As a result, the gher farming diffused rapidly with large participation of landless and marginal farmers.

4. Diffusion process of rice-prawn gher farming in Bilpabla village

The diffusion process was localized at the early stage (before 1990) of rice-prawn gher farming; however, it was expanded rapidly after 1990 within a few years in southwest Bangladesh. The first place to introduce rice-prawn gher farming was Fakirhat Thana under Bagerhat district in the mid 1980s; it is about 30 kilometers far from Khulna district. After the introduction of rice-prawn gher farming in Bilpabla village in 1990, the diffusion of rice-prawn gher farming was fast and was completed in 1997 but the speed of diffusion was not uniform between 1990 and 1997.

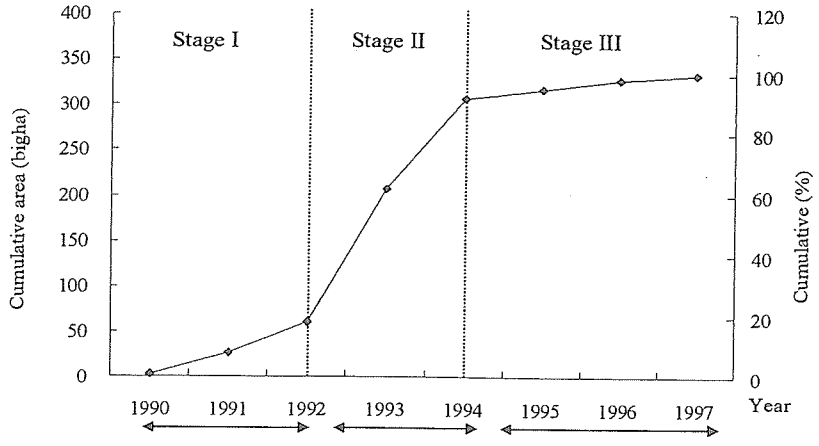

Figure 1. Diffusion process of rice-prawn gher farming in Bilpabla village from 1990 to 1997.

Source: Field surevy, 2003.

The diffusion of gher farming in Bilpabla village, which is presented in Figure 1, can be divided into three stages. At the first stage (1990-1991), only the introducer produced prawn and the success of this new agricultural system influenced other farmers (relatives and

neighbors of the introducer) to convert their paddy fields into gher farming the following year. In the second stage (1992-1994), the diffusion process of gher farming was faster than the first stage because at that time the absentee landlords rented out their swamplands and lowland paddy fields to marginal and landless farmers on a fixed-rent basis (see Table 2). The main reasons were that both parties of the tenurial arrangement benefited from the new agricultural system. On one side, the landlords got fixed income from renting out their farmlands while the tenants earned agricultural income along with self-employment that was not possible before the gher revolution. In other words, the participation of a large number of absentee landlords, and landless and marginal farmers worked to diffuse rice-prawn gher farming rapidly. At this stage, about 85% of paddy fields were converted into gher farming. The remaining comparatively upland, fallow lands and low fertile land were converted into gher farming, and gradually all paddy farms were converted into gher farming in 1997.

5. Conclusions

Rice-prawn gher farming is an indigenous agricultural system solely developed by farmers during the mid 1980s. The rice-prawn gher farming was diffused rapidly in comparison to MV paddy farming in Bangladesh. The main reasons were that the farmers could use indigenous natural inputs such as prawn fingerlings that were collected from rivers and seas, and mud snails from swamplands, paddy fields and rivers as prawn feed at the early stage of gher farming. Moreover, the input cost was low and profit was very high. On the other hand, at the early stage of the green revolution in Bangladesh farmers had to provide equipment for irrigation, chemical fertilizers, and construction of irrigation canals, which were expensive for poor and marginal farmers. In addition to this, both the landlords and tenants benefited from rice-prawn gher farming. On one side the landlords received a fixed amount of income from renting out gher lands and on the other side, the tenants generated large amount of income from the gher farm that was not possible before gher farming. The gher farming system also diffused rapidly with the large participation of marginal and landless farmers.

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