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# Effects of controlling saline water intrusion in an empoldered area of Bangladesh

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## Abstract

The study explores the effects of controlling saline water intrusion into coastal polder areas of Bangladesh. The study was conducted at the Dacope *Upazila* of Khulna District (Polder 31) using a predesigned and pretested interview schedule involving 200 farmers. Profitability and undiscounted benefit-cost ratios of rice and shrimp were calculated. Saline water has a significant impact on crop production in the study area and the two unions of Pankhali and Tildanga have a contrasting choice of crops and cropping patterns. Considering the impact of saline water on environment and rice production, the farmers of the Pankhali union decided to control saline water intrusion and follow a rice-cum-golda (freshwater prawn) cropping pattern. By contrast, the farmers of Tildanga practiced a rice-cum-bagda (brackishwater shrimp) pattern. Water salinity differed significantly between the two unions. Average monthly salinities throughout the year in Pankhali and Tildanga Unions were 7.85 and 12.34 with standard deviations of 7.39 and 8.85, respectively. Lands remained fallow in the *boro* (dry) season. The benefit-cost ratios of golda and bagda culture were 2.12 and 3.60, respectively. Farmers in Pankhali Union were able to compensate for lower benefits from golda farming with higher returns from *T. Aman* rice (BCR 1.76) and other benefits such as grazing land, drinking water, vegetables cultivation, *boro* farming, leasing arrangements and the higher price of golda. The people of Pankhali Union were actively controlling saline water inflow to the polder, whereas those of Tildanga Union preferred saline water because of better financial benefits from bagda farming. Poor farmers of Tildanga were thinking differently; they wanted to grow more rice and vegetables to escape from *Hurry* (a leasing system) and improve access to their land. According to farmers, the salinity of Pankhali Union is gradually declining due to changed water management and cropping practices. Farmers' are interested in cultivating rice in the *boro* season and introducing salt tolerant rice varieties to improve productivity and food security. Separate water management policies are needed to facilitate increased productivity of farming at the two different areas.

**Key messages:** Controlling saline water intrusion into the empoldered area of coastal Bangladesh has an impact on rice productivity, salinity level, society and environment.

**Keywords:** water salinity, golda, bagda, *T. aman* rice

## 1. Introduction

Bangladesh has a large coastal area of 47,211 km<sup>2</sup> (32 percent of the country's geographical area), where 35 million people (28 percent of the country's total population) live in 6.85 million households. Of the country's 64 districts, 19 are considered to be coastal districts (Rahman et al. 2013). The coastal area has been inhabited for centuries but is now suffering from various development pressures; salinity intrusion is a key problem particularly affecting rice cultivation. Bagda (brackishwater shrimp) farming creates an additional pressure on coastal areas of Bangladesh and has been associated with various negative social and ecological externalities. The situation has precipitated significant debate and controversies in recent years, resulting in a number of government initiatives to manage negative impacts including enacting laws governing land leasing, release of guidelines for site selection and operation of bagda farms, requiring consent of local farmers before setting up bagda farms, and the formation of Bagda Culture Steering Bodies at national, regional and local levels. These government regulations have been criticized on the grounds of their inadequacy, weak enforcement and non-sensitivity to environmental concerns (WorldFish Center 2009).

The effects on rice production are considered significant in coastal Bangladesh; the productivity of rice in the region is lower (3.0 ton/ha) than the potential yield (5.5 ton/ha) of modern varieties. Salinity has become a problem for livestock and forestry also, reducing options for diversification particularly by poorer farmers. Cultivation of rice-cum-golda (freshwater prawn) rather than rice-cum-bagda has become a suitable alternative in some areas, avoiding use of saline water and allowing rice culture. Widespread adoption of this method appears to be limited at present as larger farmers prefer shrimp culture with saline water, a practice that constrains options for less influential farmers.

Rice takes the monopoly position as a staple food of the country and salinity has significant impact on production of this staple. Recognizing this, people of the Pankhali Union of polder 31 in Khulna District banned the intrusion of saline water and brought more land under the cultivation of *T. Aman* rice, following a rice-cum-golda cropping pattern instead of rice-cum-bagda (Rahman et al. 2013). This study was designed to evaluate the effect of this initiative to control saline water intrusion into polders.

## 2. Methodology

Dacope *Upazila* of Khulna District was selected as the study area, with Pankhali and Tildanga Unions selected for in-depth study because they reflected contrasting cropping and salinity conditions. A stratified random sampling was used to select 200 (100 from each Union) farmers with two different cropping patterns (rice-cum-golda and rice-cum-bagda). Primary data were collected using a structured interview schedule. Both descriptive statistics and activity budgeting were used for data analysis. The productivity and profitability of rice and golda/bagda cropping was assessed using the following algebraic equation:

$$\pi = TR - TC$$

$$\pi = \sum Q_y \cdot P_y + \sum Q_b \cdot P_b - \sum_{i=1}^n (X_i \cdot P_{xi}) - TFC$$

Where,

- $\pi$  Net returns from production (Tk/ha);
- $Q_y$  Total quantity of product (kg/ha);
- $P_y$  Per unit prices of the product (Tk/kg);
- $Q_b$  Total quantity of the concerned byproduct (kg/ha);
- $P$  Per unit prices of the relevant byproduct (Tk/kg);
- $X_i$  Quantity of the concerned  $i^{\text{th}}$  inputs;
- $P_{xi}$  Per unit price of the relevant  $i^{\text{th}}$  inputs;
- $TFC$  Total fixed cost involved in production;
- $i$  1, 2, 3, ..., n (number of inputs).

## 3. Result and discussion

### 3.1 Impacts of bagda farming in Tildunga Union

This section provides a qualitative description of the impacts of bagda farming in the Tildunga Union. A comparison of environment and farming systems is provided in Section 3.2.

#### 3.1.1 Effect on forestry

A significant impact of salinity on presence and growth of trees was observed in Tildunga Union, with few indigenous fruit trees present. Older people reported a continuous reduction of indigenous trees in Tildunga,



in contrast to the considerable development of indigenous trees in Pankhali Union. Reduction of indigenous trees and dominance of mangrove trees provides an indication of the impact of salinity on forestry. Mangrove trees (namely 'Gewa' - *Excoecaria agallocha* and 'Golpata' - *Nypa fruticans*) were notably more abundant in the Bagda *gher* areas.



Fig. 1. Development of mangrove trees in bagda *ghers*.

### 3.1.2 Unfavorable environment for crops and vegetables

Farmers wishing to grow rice and vegetables in Tildunga Union faced constraints associated with salinity in the water and soil. The effect of salinity on crops depends on the degree of salinity at critical stages of growth, but overall declines in productivity with exposure to salinity were reported. Only a small number of farmers grew some vegetables. Several aquatic plants and weeds were reported to be absent from now saline areas including *Durba*, *Baju*, *Chehur*, *Tankuni*, *Halencha*, *Malanshak*, *Kalmisak*, *Ambalisak*, *Kachuri Pana* and *Shapla*. Older people in particular reported such historical changes.

### 3.1.3 Scarcity of grazing land for livestock production

Saline water brought into *gher* areas for bagda farming in Tildunga Union has also resulted in a reduction in land for livestock grazing, limiting opportunities for livestock production among farmers in the area. The shrinkage of paddy area associated with expansion of bagda farming has also led to an acute shortage of rice straw, which resulted in negative impacts on the livelihoods of poorer families dependent on cattle rearing.



Fig. 2 No feed for livestock; the cow is grazing on algae in the *gher*.

### 3.1.4 Reduction in rice producing areas

Saline intrusion associated with bagda culture has left areas unsuitable for rice cultivation in Tildunga Union. Standing saline water in the polder damages rice crops and has an adverse effect on rice yields. Poor dyke construction by gher owners exacerbates the problem, leading to saline water leaking out or flooding adjoining rice fields. Poor rice farmers have less influence than richer and influential gher owners and as a consequence rice growing opportunities have become more restricted within the Union.

### 3.1.5 Shortage of drinking water

People of Tildunga Union area generally drink pond water that is also used for other homestead activities. Bagda cultivation has led to flooding of the area with saline water and contamination of pond water with salt. Local farmers have tried to resist construction of bagda ponds near freshwater ponds, leading to social tensions and clashes in Tildunga Union. Poorer people in particular faced acute problems with access to drinking water, with rainwater becoming the only source of water for drinking and other domestic uses. Depletion and salinization of freshwater supplies means women and children have to walk increasingly long distances to collect clean water.



Fig. 3. Women and children have been the greatest victims of bagda culture developments.

### 3.1.6 Impact of bagda on society

Bagda farming has significant impact on society. Increased income for bagda farmers increases the ability to save and further invest in other employment opportunities, leading to overall better socioeconomic conditions among bagda farmers. Small farmers within Tildunga Union suffer from improper leasing arrangements (known locally as 'Hurry') that led to social conflict. In the *Hurry* system, large farmers lease the land of small farmers. Small farmers have no choice but to lease out the land for whatever money the rich farmers offer for it, with limited bargaining power. Large farmers use their control of canal water to their benefit, as there is no alternative irrigation system.

The overall impact of bagda farming is shown in the flow diagram below.

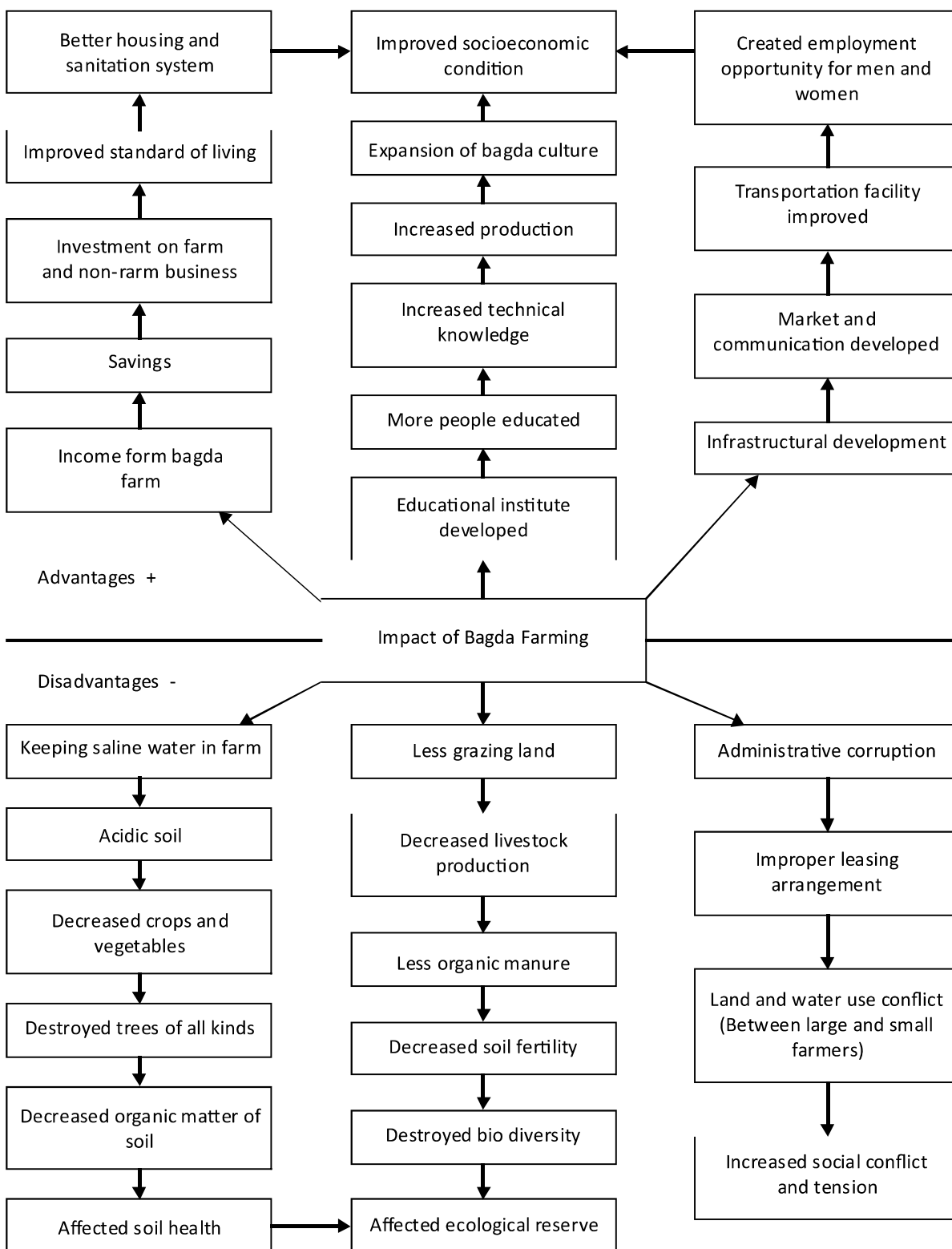


Fig. 4. Impact flow diagram of bagda farming.



### 3.2 Effect of controlling saline water intrusion in Pankhali Union

#### 3.2.1 Water salinity of Pankhali and Tildanga Unions

Following the restriction of saline water intrusion in Pankhali Union, its water salinity levels changed significantly from those of Tildanga Union. Salinity varies from month to month, with lower salinity during the months of August to December and higher during the months March to June (Figure 5). The average salinity of Pankhali and Tildanga was 7.85 dS/m and 12.34 dS/m, respectively. The lowest salinity (0.50 dS/m) of Pankhali Union occurred during September and that of Tildanga (1.95) was during November. The highest water salinity occurred in Pankhali and Tildanga during the months of April (19.75 dS/m) and May (26.50 dS/m), respectively (Table 1).

Table 1. Comparative salinity of Pankhali and Tildanga unions

Area (union)	Monthly water salinity (dS/m)			
	Minimum	Maximum	Mean	Std. Deviation
Pankhali	0.50	19.75	7.85	7.39
Tildanga	1.95	26.50	12.34	8.85

Source: Soil Resource Development Institute (2012), author's calculation

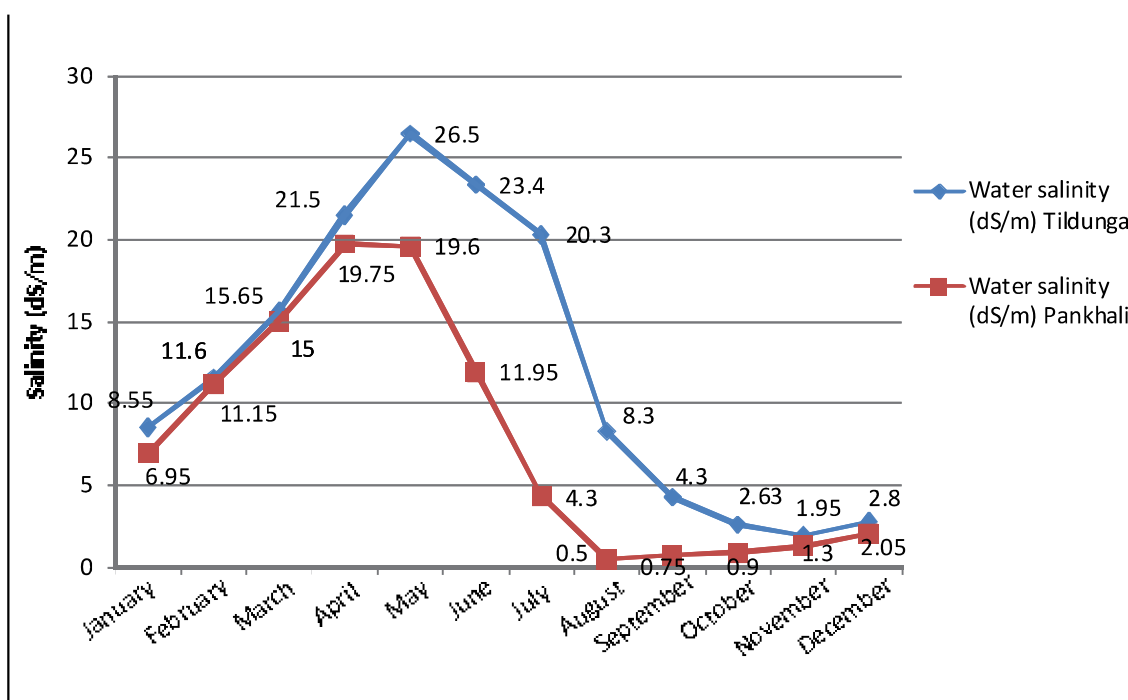


Fig. 5. Comparative salinity of Pankhali and Tildanga Unions (source: Soil Resource Development Institute (2012)).

#### 3.2.2 Productivity of *T. aman* rice and prawn/shrimp in Tildanga and Pankhali Unions

The productivity of rice also differed between the different salinity areas. The productivity of rice is marginally higher in the lower salinity areas than that of higher salinity areas. On average the productivity of rice in Pankhali Union was 3,098 kg/ha and 3,005 kg/ha in Tildanga Union (Table 2). This indicates that water salinity has some impact on the productivity of rice in the study area. However, the productivity of golda at Pankhali was higher than that of bagda at Tildanga.

Table 2. Productivity of rice and shrimp in Tildunga and Pankhali unions

Area	Mean productivity (kg/ha)	
	Rice	Shrimp (golda/bagda)
Pankhali Union	3098.20	254.94
Tildunga Union	3004.72	233.18

### 3.2.3 Comparative gross margin, net return and BCR of T. Aman rice and shrimp

Although the gross return from golda was higher in Pankhali Union than that of bagda in the Tildunga Union, the benefit cost ratio (BCR) of bagda (3.60) was higher than that of golda (2.12). The reason for this is the low investment cost of bagda (shrimp). The gross return and BCR of rice production, though low, was higher in Pankhali Union than Tildunga Union (Table 3), as salinity was lower in Pankhali Union.

Table 3. Comparative per hectare costs and return of T. Aman rice and shrimp farming

Items	Shrimp farming		T. Aman rice farming	
	Pankhali Union (mostly golda)	Tildunga Union (mostly bagda)	Pankhali Union	Tildunga Union
Gross returns (Tk/ha)	446,025.00	221205.00	58,237.00	47958.00
Variable costs (Tk/ha)	131,898.00	54458.00	25,736.00	31999.00
Gross margin (Tk/ha)	314,127.00	41592.00	32,501.00	15959.00
Fixed costs (Tk/ha)	78,547.00	7612.00	7,418.00	8033.00
Total costs (Tk/ha)	210,445.00	62070.00	33,154.00	40032.00
Net returns (Tk/ha)	235,580.00	159135.00	25,083.00	7926.00
BCR	2.12	3.60	1.76	1.20

Source: Field survey (2012).

## 4. Conclusion

Realizing the environmental, social and rice yield impacts of bagda cultivation with saline water, the people of Pankhali Union became interested in cultivating golda instead of bagda. The community has restricted the intrusion of saline water into the polder area. People of that area were happy enough as the system was beneficial for rice farming and resulted in better quality water for drinking. Small farmers reported that they had removed the curse of *Hurry*.

Although poor and small farmers benefited by restricting the entry of saline water, larger *gher* farmers were reported to be unhappy as it hampered bagda farming. Rice takes the monopoly position as the staple food item throughout the country and saline water intrusion for bagda culture hampered rice cultivation. The preference for bagda is clearly driven by significantly higher financial benefit (BCR was 3.60). Farmers in Tildunga Union were also thinking of introducing-salt tolerant rice varieties to solve the existing problem of culturing rice alongside bagda. The farmers of both areas want to be satisfied with the existing farming situation of rice-golda and rice-bagda. However, different water management policies should be adopted within the respective areas to facilitate better management of water for rice-golda and rice-bagda farming.

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