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# Farmers' Profitability of Shrimp Farming

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## Abstract

The purposes of the study were to describe the socio-economic profile of shrimp farmers and to find out the factors influencing farmers' profitability of the shrimp farming in the study area. The study was conducted in Bagerhat and Khulna districts of Bangladesh. A total number of 120 shrimp farmers were selected randomly as the sample of the study. The final data were collected during 1st November to 31st December, 2017 by using an interview schedule. Ten selected characteristics of the farmers were considered as the independent variables of the study. Farmers' profitability of shrimp farming was considered as the dependent variable. The majority (55.8%) of the farmers said that shrimp farming is profitable. Multinomial logistic regressions analysis indicated that age, level of education, family size, experience in shrimp farming and organizational participation had significant positive contribution to their profitability. They were faced different problems in different level which are needed to mitigate by both public and private initiatives to increase the level of profitability.

**Key words:** Farmer, profitability, shrimp farming and Bangladesh.

## Introduction

Shrimp plays a very important role in the economy of Bangladesh. About 65% of exported fish products of this country is shrimp. Shrimp export and cultivation in Bangladesh has undergone rapid expansion over the last two decades. Shrimp and prawn together represent the second largest exportable items contributing to foreign exchange earnings of Bangladesh. Shrimp is a particularly valuable export crop generating substantial revenues and foreign exchange; earning in excess of US$360 million annually and accounting for 4.9 percent of exports in 2004. Not only this sector earns valuable foreign exchange, but also employs significant numbers of rural workers and provides a livelihood for households throughout Bangladesh. The contribution series of upstream and downstream activities related to shrimp culture such as harvesting, culture, processing and exporting [1].

The shrimp/ prawn industry consists of distinct sub-sectors such as shrimp gher, shrimp hatcheries or post larvae (PL) collection, feed processing mills and shrimp processing and exporting plants. All these sub-sectors are linked together and constitute a horizontal integration of activities that create independent employment opportunities for males and females. Bangladesh Shrimp and Fish Foundation estimate that there are over 600,000 people employed directly in shrimp aquaculture who support approximately 3.5 million dependents [2].

Despite the rapid growth of Bangladeshi shrimp cultivation, the global frozen fish and seafood market continues to be dominated by Thailand, Indonesia, China and Ecuador. Significant innovations in production and processing in these countries have increased the value added associated with their exports and the market share that they command. Unfortunately, the same is not true for Bangladesh. Innovations in both production and processing have yet to be secured. Furthermore, stricter import requirements and compliance regulations in importing countries have meant that Bangladesh must invest in improving the safety and quality of their fish and seafood exports to avoid products being detained and rejected at point of entry into foreign markets. IFPRI (2003) report notes that: "The only way Bangladesh can improve its export position in the shrimp market is to improve the safety and quality of its exports." "Roughly 33 per cent of the shrimps grown in Bangladesh are exported" told by [3]. Though shrimp fetch a large amount of foreign exchange through exports, it is not an.

Commercial shrimp culture has been dramatically expanded over the last three decades in the coastal zone of Bangladesh [4]. In FY 2016-17, the total amount of production from shrimp farm including secondary crop fish and crab was 246406 MT in Bangladesh with a significant growth rate of 2.76% [5]. Shrimp is the second most important export items in Bangladesh. The major shrimp-producing districts are Bagerhat, Satkhira, Pirojpur, Khulan, Cox's Bazar and Chittagong. Among them, Chittagong, Cox's Bazar, Khulna, Bangerhat and Satkhira districts are the main centers of shrimp culture [6]. Although several species are available in the coastal regions, Penaeusmonodon (locally known as bagdachingri) is the preferred species for cultivation as very high price in international markets. In Bangladesh, P. monodon comprises 60 % of farmed shrimp production, followed by the giant freshwater prawn, Macrobra chiumrosenbergii

(galdachingri), which accounts for25 % of production [7] and [8]. Thus,of the fishery commodities exporting shrimps like Black Tiger (Penaeus Monodon) and fresh water scampi (Macrobrachium Rosenbergii) bring the most of foreign currency in this sector. Traditional 'Gher' (shrimp farming ponds which are converted from rice field) aquaculture had been practiced in the coastal region of Bangladesh to grow shrimp and other fishes long before the introduction of current shrimp farming practices.

In the Second Five-Year Plan (1980-1985), the government of Bangladesh acknowledged shrimp farming as an industry and adopted measures essential for increased shrimp production [9]. After that the production grew exponentially and the area covered by production was 22,000 ha in 1980 that increased to almost double (276,000 ha) in 2013[10] and [11]. Total shrimp production takes place from three sources, namely inland capture, inland culture and marine fisheries. In 1990–1991, total shrimp production was 80,384 tons in which cultured shrimp contributed 24 %. But, in 2010–2011, the total shrimp production increased to 306,168 tons of which cultured shrimp contributed 47.71 %. That means the shrimp production share from the culture sources increased by 23.47 % as compared to 1990–1991 [12].The economic incentives encourage farmers to bring thousands of acres of lands under shrimp farms [13].

1. To describe the socio-economic profile of shrimp farmers;
2. To find out the factors influencing farmers' profitability of the shrimp farming in the study area;

## Methodology

### Locale of the study

This study was done in the two districts of Bangladesh namely; Khulna and Bagerhat. Khulna District has a total area of 4,389.11 square kilometres (1,694.64 sq mi). It borders Jessore District to the north, Narail District to the northeast, Bagerhat District to the east, the Bay of Bengal to the south, and Satkhira District to the west. Bagerhat district has a total area of 3959.11 square kilometres. It is bounded by Gopalganj District and Narail District on the north, The Bay of Bengal on the south, Gopalganj District, Pirojpur District and Barguna District on the east and Khulna District on the west. Two upazilas from each two districts namely; Dumuria and Paikghachha of Khulna and Bagerhat sadar and Rampal of Bagerhat was selected purposively as the locale of the study.

### Sampling and data collection method

To investigate the farmers' profitability of shrimp farming, a well-structured interview schedule (questionnaire) was developed based on the objectives of the study. The schedule contained both open and closed form questions. The interview schedule was pre-tested with 20 farmers by the researcher. Necessary additions, corrections and modifications were made in the schedule on the basis of the pre-test results. The final data were collected from the selected 120 farmers with using questionnaire. Questions were asked systematically and explanation was made whenever necessary. The respondents were interviewed at their leisure time so that they can give accurate information in a cool mind. To build rapport and motivation in the interview situations, the researcher endeavoured to provide conditions that maximum trust maintained each respondent's interest and minimized the status difference. The final data were collected from 1st November to 31st, December 2017. The distribution of population and sample was shown in Table 1.

**Table 1:** Population and sample of the study area

| Name of the district | Name of the upazila | Sample size |
|---|---|---|
| Bagerhat | Bagerhat Sadar | 30 |
| | Rampal | 30 |
| Khulna | Paikgacha Upazila | 30 |
| | Dumuria Upazila | 30 |
| | **Total** | **120** |

### Dependent and independent variables

In this study, the multinomial logistic regression model was used to identify the factors influencing farmers' profitability of shrimp farming in this study area. We assume that farmers will profit only if they perceive a reduction in risk to shrimp farming or an increase in expected net benefits. Consider a multinomial variable (Y*ij) which is equal to expected benefits from the profitability of shrimp farming.

$$Y*ij = \alpha + \sum \beta k\, Xk + Y*ij$$

In this equation, Y*ij is a multinomial variable with subscript I depicting the farmers who profited to shrimp farming and j depicting profitability. Xk represents the vector of exogenous explanatory variables that influence the farmers' profitability shrimp farming and k in the subscript shows the specific explanatory variable. The symbol α denotes the model intercept, βk the vector of multinomial logistic regression coefficients and Y*ij is the error term which is normally distributed and homoscedastic.

### Description of explanatory variables

The selection of explanatory variables used in this study is based on the data availability and past review of literature. The explanatory variables such as farmers socio-economic characteristics ( e.g., age, level of education, family size, credit received, income from shrimp farming, experience in shrimp farming, adopter, training on shrimp farming, land under shrimp farming, and organizational participation.

Prior to the study, a multinomial logistic regression modeling approach was proposed to base on literature where most of the previous studies of farmer's profitability of shrimp farming employed multinomial logistic regression model, the farmers are restricted to select one from a given set of profitability. Furthermore, the set of explanatory variables influencing the respondents' decision was also expected to be different for

different farmer's profitability of shrimp farming. Therefore, we used the multinomial logistic regression model to identify the factors that affect the farmer's profitability of shrimp farming. Table 2 shows the description and expected signs of explanatory variables used in this study.

**Table 2:** Variables used in multinomial logistic regression model and their description

| Explanatory variable | Mean | SD | Description |
|---|---|---|---|
| Age | 41.82 | 11.42 | Continuous |
| Level of education | 7.67 | 4.62 | Continuous |
| Family size | 4.34 | 1.38 | Continuous |
| Credit received | 110.86 | 30.85 | Continuous |
| Income from shrimp farming | 258.37 | 117.92 | Continuous |
| Experience in shrimp cultivation | 13.61 | 7.41 | Continuous |
| Adopter | 1.38 | 0.48 | Dummy, takes the value of 1 if adopter and 0 otherwise |
| Training on shrimp cultivation | 2.75 | 1.83 | Continuous |
| Land under shrimp cultivation | 0.8060 | 0.60 | Continuous |
| Organizational participation | 3.61 | 3.24 | Continuous |

| Dependent variable | Mean | SD | Description |
|---|---|---|---|
| Profitability of shrimp farming | 0.56 | 0.499 | Dummy, takes the value of 1 if yes and 0 otherwise |

We began our analysis by measuring farmer's profitability of shrimp farming and change in Bangladesh. Profitability was measured using multinomial logistic regression model.

We assessed determinants overall farmer's profitability of shrimp farming. We modeled farmer's profitability of shrimp farming using a profitability index. Using multinomial logistic regression models, the farmer's profitability of shrimp farming index was regressed on a set of explanatory variables to access determinants of profitability of shrimp farming. Therefore, many factors are likely to influences farmer's profitability of shrimp farming.

Then, we modeled individual farmer's profitability of shrimp farming in order to get better assess the influences associated with profitability. Our dependent variables in this aspect were farmer's profitability. Its strategy was a dummy variable equal to 1 if a farmer grain profitability from shrimp farming and 0 if otherwise.

## Hypothesis testing for model significant

We tested all of our models for significance and accuracy of predictions. There are various paths to measure correctness of fit for multinomial logistic regression models. In the first step, we used the classification table method to measure the extent to which our models accurately predict the dependent variables (in our study, farmer's profitability of shrimp farming). The classification table is estimated by comparing the predicted scores of observations, on the basis of explanatory variables in our study model, with their actual responses given in the data. Higher percentage indicates a better fit of the model.

In the second step, to test the overall significance of models, we used a global null hypothesis approach. For this analysis, we established a null hypothesis by assuming and setting all the regression coefficients of multinomial logistic regression models equal to zero versus the alternative that at least one of the regression coefficients (βk) is not zero.

$$H0: \beta k = 0,$$

$$H1: \text{at least one } \beta k \neq 0.$$

This approach is the same as the F test for model testing in OLS regression. This test checks whether the model with predictors, fits significantly better than the model with just an intercept.

The test statistic is calculated by taking the difference of the residual deviance for the model with predictors or explanatory variables from the null deviance of intercept-only model. The test statistic is distributed $\chi 2$ with a degree of freedom that is equal to the differences between the number of variables in the model with predictors and intercept-only model.

From the Table 3, it can be examined that $\chi 2$ values for all profitability models are positive. The associated p values are less than 0.001 which it can be concluded that our models with predictors fit significantly better than the intercept-only model. Hence, on the basis of test statistics, we can reject the null hypothesis (H0) and accept the other alternative hypothesis (H1) that at least one of the regression coefficients (βk) is zero.

Further, we calculated the Nagelkerke R2 measure to determine the correctness of fit of our profitability models. The values of Nagelkerke R2 for all models are 0.294 which indicates a better fit of our models in explaining farmer's profitability of shrimp farming.

**Table 3:** Hypothesis testing for model significance and predictive power

| Models | $\chi^2$ (Chi-squared) | Degree of freedom (df) | p value | -2log likelihood | Cox & Snell $R^2$ | Nagelkerke $R^2$ | McFadden |
|---|---|---|---|---|---|---|---|
| **Profitability of shrimp farming** | 29.767 | 11 | 0.000 | 134.951 | 0.220 | 0.294 | 0.181 |

Based on the results from the classification table, global null hypothesis and Nagelkerke R2, it can be assumed that all the models selected for this study are fit and accurately estimate the factors affecting farmer's profitability of shrimp farming.

## Model Results and Discussion

The estimated co-efficient of the multinomial logistic regression model, level of significant along with, are presented in Table 4. The likelihood ratio statistics as indicated by $\chi 2$ statistics are highly significant ($p<0.002$), suggesting the model has a strong explanatory power.

With respect to socio-economic features of the farmers, the shrimp farmers were classified into three age categories such as young, middle and old aged. Out of the total farmers 20 percent belonged to the young, 48.3 percent belonged to the middle and 31.7 percent fell into the old aged. Out of 120 farmers, 10 percent farmers had illiterate, 26.7 percent farmers had completed primary education, 40.8 percent farmers had completed secondary level of education, and 22.5 percent farmers had completed their above secondary level of education. Data showed that the highest proportion (67.5%) of the farmers fell into the medium family of 4-6 members, while (26.7%) of them fell into the small family size of 2-3 members and (5.8%) fell into the large family size of above 6 members. About 2.5% farmers were taken loan from Banks, 20% farmers were taken credit from NGOs and no farmers were taken loan from their relatives as reported by the farmers and 77.5% farmers were used their own funding. About 50% of the shrimp farmers had earned Tk. 100,000 to 200,000 per year, 15.8 percent of the farmers had earned Tk. less than 100,000 per year and 34.2 percent farmers had earned Tk. above 200,000 per year. Data revealed that the majority (60.2%) of the farmers had medium experience as compared to (15.8%) and (20.8%) having high and low experience respectively. Data revealed that the majority (67.5%) of the farmers had adopter and (32.5%) had non-adopter respectively. Data indicated that the majority (53.3%) of the farmers had low training on shrimp farming that comprised by 36.7% and 4.2% farmers have low training and medium training on shrimp farming. Only (5.8%) of the respondents had high training on shrimp farming. Data revealed that 73.3%, 25.9% and 0.8% of the farmers had small land, medium land and high land respectively. The data indicated that the majority (50.8%) of the farmers had no organizational participation and 49.2 percent farmers had organizational participation.

**Table 4:** The salient feature of the farmers

| Characteristics | Percent (%) |
|---|---|
| **Age** | |
| Young (18-30 years) | 20.00 |
| Middle (31-45 years) | 48.3 |
| Old (Above 45 years) | 31.7 |
| **Education** | |
| Illiterate/can sign only( 0 ) | 10 |
| Primary level( 1-5 ) | 26.7 |
| Secondary level( 6-10 ) | 40.8 |
| Above secondary level( >10 ) | 22.5 |
| **Family size** | |
| Small (2-3) | 26.7 |
| Medium (4-6) | 67.5 |
| Large (above 6) | 5.8 |
| **Credit received** | |
| Banks | 2.5 |
| NGOs | 20 |
| Relatives | 0 |
| Own funding | 77.5 |
| **Income** | |
| Less than 100,000 | 34.2 |
| 100,000 to 200,000 | 15.8 |
| Above 200,000 | 50 |
| **Experience in shrimp farming** | |
| Low experience (3-7) | 20 |
| Medium experience (8-21) | 60.2 |
| High experience (above 21) | 15.8 |
| **Adopter** | |
| Adopter (1) | 67.5 |
| Non-adopter (2) | 32.5 |
| **Training on shrimp farming** | |
| No training (0) | 36.7 |
| Low training (1-5) | 53.3 |
| Medium training (6-10) | 4.2 |
| High training (above 10) | 5.8 |
| **Land under shrimp farming** | |
| Small (0.13-1 ha) | 73.3 |
| Medium (1.01-3 ha) | 25.9 |
| Large land (above 3 ha) | 0.8 |
| **Organizational participation** | |
| No participation (0) | 50.8 |
| Participation (1) | 49.2 |

### Factors affecting farmer's profitability of shrimp farming

To identify the impact of various explanatory factors affecting farmer's profitability of shrimp farming, we used multinomial logistic regression models for all farmers' profitability of shrimp farming measures. The coefficients of multinomial logistic regression that tell us about the direction of explanatory variables are presented in the Table 5 and the original effects that explain the effect of a unit change in explanatory variables on the dependent are shown in the Table 5.

### Age

The coefficient of age in profitability of shrimp farming indicating a positive relation between age and profitability of shrimp farming. According to the results in Table 5, age significantly increases the probability of profitability of shrimp farming. Table 5; show that a 1% increase in age increases the probability of profitability of shrimp farming (0.976%). Hence, it can be concluded that farmers with increasing age are likely to be more aware of past climate events and best judge to do their farming to bad weather events.

**Table 5:** Parameter estimates of the multinomial logistic regression models of farmer's profitability of shrimp farming

| Explanatory variables | Profitability of shrimp farming | | | | |
|---|---|---|---|---|---|
| | B | Std. Error | Wald | Sig. | Exp(B) |
| **Age** | 0.025 | 0.023 | 1.131 | 0.088* | 0.976 |
| **Level of education** | 0.136 | 0.052 | 6.893 | 0.009*** | 0.873 |
| **Family size** | 0.348 | 0.174 | 4.001 | 0.045** | 0.706 |
| **Credit received** | 0.007 | 0.008 | 0.613 | 0.434 | 0.993 |
| **Income from shrimp farming** | 0.001 | 0.002 | 0.190 | 0.663 | 0.999 |
| **Experience in shrimp farming** | 0.063 | 0.035 | 3.313 | 0.029** | 1.065 |
| **Adopter** | 0.320 | 0.455 | 0.494 | 0.482 | 0.726 |
| **Training on shrimp farming** | 0.028 | 0.050 | 0.309 | 0.578 | 1.028 |
| **Land under shrimp farming** | -0.128 | 0.362 | 0.125 | 0.723 | 0.880 |
| **Organizational participation** | -0.285 | 0.093 | 9.500 | 0.002*** | 0.752 |

### Level of education

Level of education is an important factor in increasing profitability of shrimp farming. In our study, the highly significant coefficient of education of the farmers shows that the probability of profitability of shrimp farming to changes in profitability increases with an increase in years of schooling. The result shows that 1% increase in the years of schooling of the farmers would lead to increase in the probability of profitability of shrimp farming (0.873%). Therefore, it can be concluded that farmers with more years of schooling are more likely to profitability of shrimp farming compared to the farmers with no education. The finding is similar to the studies of [14]

### Family size

For profitability of shrimp farming, increasing family size has significantly increasing the probability of profitability. There is a positive coefficient between family size and probability of profitability. There is an assumption is that large family size is normally associated with a higher labour endowment, which would enable a household to accomplish various agricultural activities. It can be concluded that farmers with large family size are more likely to profit compared others variables.

### Experience in shrimp farming

The coefficient of years of experience of farming has a positive sign in profitability, indicating a positive relation between farming experience and possibility of profitability. The calculations in the Table 4 show that a 1% increases in years of farming increases the probability of profitability (1.065%). Hence, it can be concluded that farmers with greater farming age are likely to be more aware of past climate events and better judge how to adapt their farming to extreme weather events. So that they can grain more profit than others farmers.

### Organizational participation

Multinomial regressions showed that organizational participation of the farmers has a positive contribution for profitability of shrimp farming. This implies that with the increase of organizational participation will also increase farmers' profitability. Organizational participation helps to know different knowledge about shrimp farming. This finding indicated that farmers' have more organizational participation increased the farmers' profitability of shrimp farming. The finding is similar to the studies of [14].

## Conclusions and Policy Implications

The study uses the multinomial logistic regression model to identify the factors influences farmers' profitability. In this model, the dependent variable was profitability and the explanatory variables include farmers, different socio-economic characteristics. The statistical test indicated that there are no multicollinearity problems in the fitted model. This study tried to find out the socioeconomic status and profitability of shrimp

farming. Financial profitability was measured from different point of view. It was revealed that most of the farmers were in prime working age group. They completed primary level of education while a few of them were illiterate. Family size of the farmer's was medium (67.5%). Experience can play an important role in farmers profitability of shrimp farming but in this study about 60.2% of the farmers had medium experience in shrimp farming. It can be recommended from the study that shrimp farmers should continue their business and should not give lease their land to the large farmers.

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