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SHRIMP PRODUCTION AND ITS EFFECTS ON FAMILY INCOME INEQUALITY IN SOME SELECTED AREAS OF KHULNA DISTRICT

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A B S T R A C T

This study attempted to find out the determinants of shrimp production and to assess the effects of income from shrimp production on family income inequality in Khulna district of Bangladesh. Forty-five farmers were selected from the Bhanderkote union of Batiaghata Upazila under Khulna District. Among them 15 were small farmers, 22 were medium farmers and 8 were large farmers. Data were collected from May to July 2014 through face to face interview. Ordinary Least Square had been used to find out the determinants of shrimp production. Gini coefficient was measured to see the effects of family income inequality. Expenditure on shrimp fingerling, feed, lime, education, and hired labor were the important determinants and had significant effects on shrimp production. Shrimp farm incomes were equal among all categories of farmers (small, medium and large) and all farmers bear the value of Gini0.31, 0.24, 0.12 and 0.36 respectively. In the case of non-farm incomes small, large and all farmers were relatively equal (G=0.49, G=0.42, and G=0.44 respectively) where the medium farmers (G=0.55) were relatively unequal.

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INTRODUCTION

In the agro-based economy of Bangladesh, three-fifths of the population engages in farming representing about 47.33 percent agricultural labor of total labor forces (BER, 2012). The fisheries sub-sectors share 4.43 percent (DoF, 2011) beneath 19.29 percent agricultural contribution (BER, 2012) to the Gross Domestic Product (GDP) of this economy as a whole. The high population growth rate (1.37 percent) (BER, 2012) with low agricultural productivity and natural hazards adversely affect the living standards of the people in the country. Fisheries sub-sector is becoming the most important and promising sub-sectors through mitigating increased food demand and contribute to her economic development as it earns foreign exchange and generate employment for rural poor. Fish provides 60% of national animal protein consumption. In Bangladesh per capita annual fish intake, 18.94 kg and annual total fish needed 20.44 lakh MT. In 2010-11, Bangladesh earned BDT 4603.83 crore by exporting fish and fish products whose amount was 96469 tons by exporting the maximum amount (about 98%) in the major importing countries(European countries, the USA and Japan) and the rest in Southeast Asia and the Middle East. Major export items of fish products are raw shrimp block frozen, IQF shrimp and white fish, PUD and P&D shrimp block frozen, consumer pack of raw frozen shrimp, chilled & frozen Hilsa, dry, salted and dehydrated fish, live fish, and crab and a little quantity of value-added fish and shrimp products.

Bangladesh has about 6, 78,724 ha of closed water body where shrimp farms cover 2,76,492 ha and 40,24,934 ha of open water body. (DoF 2011).Shrimp farming production systems are technically diverse such as traditional, extensive, semi-extensive, intensive, super-intensive and improved extensive. Most of the shrimp culture is being practiced by the extensive and improved extensive methods, known as '*gher*' culture in Bangladesh. The '*gher*' are generally situated in low-lying coastal region, especially the south-western portion (Satkhira, Khulna, and Bagerhat), which is one of the most promising areas for shrimp cultivation for two major reasons: first, its abundant fresh and salt-water resources availability: second, the Sundarbans, provides a food source and nursery for the offshore fishery. The mangrove forests provide critical habitat for shrimp and other fish. Shrimp cultivation has been adopting and spreading dramatically in Khulna and Satkhira, and introducing as the most attractive economic investment opportunities since 1990 (Ahmed 2001). For increasing demand in the international market, shrimp farming has expanded in north-central (Mymensingh) along with southern Bangladesh (Noakhali and Patuakhali) (Asaduzzaman *et al*. 2007). As an agricultural country, Bangladesh needs to emphasize exports of agricultural or related commodities and products. Among agricultural commodities, fisheries constitute the majority of exports (Table 1). Shrimp is the largest agro-export earner in Bangladesh. The quantity and value of frozen shrimp exported in the last five years show that frozen shrimp is the major item among the exported shrimp. (table 2). The value of shrimp exports has increased by 15 times from US$ 30 million in 1979 to US$ 440 million in 2006, an annual growth rate of 9.4% (The Executive Times, 2010). Bangladesh is already among the top 10 exporters of shrimp in the world and accounts for about 3% of global production (Mondal 2012).

To increase the production of shrimp farming to the maximum possible extent, it is necessary to identify the determinants behind the yield variations so that policy interventions may be made accordingly. As shrimp plays an important role in the economy of Bangladesh, it may be an important matter to know how shrimp production affects family income inequality of shrimp producers. It may tell about a possible situation of shrimp farmers in Bangladesh whether it will be better or not. This study has tried to find out the determinants affecting the productivity of shrimp farms and to show the impact of shrimp production on family income inequality to make a better possibility of shrimp production among the shrimp producers.

METHODOLOGY

The study was based on primary data. Primary data were collected during the period from mid-May to mid-July, 2014. The study area was purposively selected considering the higher concentration of shrimp production. Thus the primary data were collected from Noaltola and Shiyalidanga of Batiaghata Upazila of Khulna district depending upon the concentration of shrimp farms. Data were collected from 45 selected shrimp farmers' through face to face interview method. The shrimp farmers were categorized into three groups, such as;

Small: holding area 0.05-2.49 acre,
Medium: holding area 2.50-7.49 acre, and
Large: holding area 7.50 & above

The categories had 15, 22 and 8 farmers respectively (table 3). All data were carefully checked for completeness and summarization. Then it was transferred to MS excel sheet and SPSS in a systematic way for analysis. Conventional descriptive type statistics (like, mean, standard deviation, and percentage) frequency tables, ranking, graphical analysis, etc. were used to examine the different attributes.
The input-output relationship in shrimp farming under different farming systems was analyzed with the help of the normal OLS (Ordinary Least Square) method. This approach was used to find out the determinants of shrimp production.

To find out the most important determinants in the production process of shrimp, the following specification of the model was used.

$$Y=a+\sum b_iX_i+\sum D_i+\mu_i$$

Where,

Y=Shrimp production per shrimp farming household (kg)
b_i=Coefficient
X_i=Determinants or explanatory variables
D_i=Dummy variable
μ_i=Error term

$i=1,2,3\ldots\ldots n$ and (n=number of input)

To see the return to scale it was needed to compute elasticity of production E_p by MPP and APP.

$$E_p=\frac{MPP}{APP}$$

Where,

$$MPP=\frac{Change\ in\ output}{Change\ in\ input}\text{ and}$$

$$APP=\frac{\text{Output}}{\text{Input}}$$

Gini coefficient was measured to see the effects of family income inequality. The equation was as followed:

$$G=1-\sum_{k=1}^{k=n-1}(X_{k+1}-X_k)(Y_{k+1}+Y_k)$$

Where,
G=Gini coefficient,
X_k=Proportion or share of households and
Y_k=Proportion of their corresponding income.

The value of the Gini coefficient lies between 0 and 1. If the entire household receives the same percentage of the total income then it is 0 and if there is perfect inequality, then the value is 1. The reason for its popularity is that it is easy to understand how to compute the Gini index as a ratio of two areas and to draw in Lorenz curve diagrams. The meaning of the Gini index only can be understood empirically.

Table 1. Exports of Fish and Fish Products

Year	Source-wise production		Other Fish Products		Total Value (crore taka)	% of total export earnings
	Quantity (MT)	Value (crore taka)	Quantity (MT)	Value (crore taka)		
2010-11	54891	3568.2	41578	1035.63	4603.83	2.73
2009-10	51599	2885.21	26044	523.31	3408.52	2.74
2008-09	50368	2744.12	22520	499.29	3243.41	3
2007-08	49907	2863.92	25992	532.36	3396.28	4.04
2006-07	53361	2992.33	20343	360.56	3352.89	4.90

Source: DoF 2011

Table 2. Exports of Shrimp from Bangladesh

Year	Frozen Shrimp		% of total fish export earnings.
	Quantity (MT)	Value (crore taka)	
2010-11	54891	3568.2	77.51
2009-10	51599	2885.2	84.65
2008-09	50368	2744.1	84.61
2007-08	49907	2863.9	84.32
2006-07	53361	2992.33	89.25

Source:BBS2012

Table 3. Sampling design and distribution of sample farmers

Categories of farmers	Shrimp farmers (no)
Small	15
Medium	22
Large	8
Total	45

RESULTS AND DISCUSSION

Determinants of Shrimp Production

The productivity can be increased through one or combination of its determinants-the technology, the quantities and the types of resources used and the efficiency with which the resources are used (Goyal et al., 2006).

To see the impact of determinants it is important to identify the determinants of output and their extent of influence on output (i.e., the physical and marginal relationships between output and a host of explanatory variables) and the inputs that are significant in explaining variation in output.

For this purpose OLS (Ordinary Least Square) method, the average and marginal productivities of factors of production, the elasticity of production and returns to scale were carried out.

The dependent variable Y (shrimp production per farmer in kg) was regressed on the following factors:

X_1=Pond area (acre), X_2=Age of ponds (years), X_3=Fingerling expenditure (taka), X_4=Feed expenditure (taka), X_5=Lime expenditure (taka), X_6=Fertilizer expenditure (taka), X_7=Experience of the operator, (years), X_8=Education of the operator (years of schooling), X_9=Hired labor expenditure (taka), X_{10}=Farm income, X_{11}=non-farm income, X_{12}=Average depth of the pond (ft), D_1=Source of fingerlings (if trader/commission agent then 1, otherwise 0), D_2=Training on shrimp farming (if trained then 1, otherwise 0).

The regression equation was estimated by using the 'Ordinary Least Square' method. The stepwise procedure with criteria: Probability-of-F-to-enter≤.150, probability-of –F-to-remove≥ .160, was followed (Singh 2007).

The model of the following form was used for the analysis of finding determinants of shrimp production.

$Y=a+\sum b_iX_i+D_i+\mu_i$; i=1, 2, 3……n

Y=Shrimp production per shrimp farming household (kg)

The estimates of the regression coefficients and corresponding standard errors are given in Table 4.

Note: *, ** and *** indicate 10, 5 and 1percent level of significance, respectively, whereas NS indicates non-significant up to 0.10 level of significance.

It is evident from the results presented in Table 5 that the estimated coefficient of pond area (X_1), pond age (X_2), shrimp fingerlings (X_3), feed (X_4), lime (X_5), fertilizer (X_6) and education (X_7) are positive whereas the hired labor (X_9) is negative.

Table 4. Determinants of output estimated by Ordinary Least Square method

Explanatory variables	All farmers		
	Coefficient	**Standard error**	**t-value**
Intercept	-6.9294^{NS}	18.8089	
Pond area (X_1) in acre	7.3001	3.9991	1.8254
Pond age (X_2) in years	0.8294	0.8512	0.9743
Shrimp fingerlings (X_3) in Tk	0.0024***	0.0006	4.2031
Feed (X_4) in Tk	0.0060**	0.0025	2.4320
Lime (X_5) in Tk	0.1526***	0.0474	3.2163
Fertilizer (X_6) in Tk	0.0135	0.0087	1.5607
Education (X_7) in years	4.8261***	1.6599	2.9075
Hired labor (X_9) in Tk	-0.0099***	0.0029	3.4371
Dummy for training (D_2)	47.4422***	15.1293	3.1358
R^2	0.7878		
Adjusted R^2	0.7847		
F value	315.4***		

Source: Field survey and author's estimation, 2014

Table 5. Marginal and Average physical productivities, Elasticity of production and Economic return to scale

Input	All farmers		
	MPP	**APP**	**Ep**
Pond area (X_1) in acre	154.674	117.0833	1.3211
Pond age (X_2) in years	107.6953	44.4464	2.4230
Shrimp fingerlings (X_3) in Tk	0.0042	0.0054	0.7848
Feed (X_4) in Tk	0.0409	0.0483	0.8473
Lime (X_5) in Tk	0.3266	0.4017	0.8129
Fertilizer (X_6) in Tk	0.1061	0.3136	0.3382
Education (X_7) in years	-491.447	103.6475	-4.7415
Hired labor (X9) in Tk	0.0527	0.0631	0.8340
Return to scale	2.6197		

Source: Field survey and author's estimation, 2014

Table 6. Measurement of Inequality of Shrimp Farm Income and Non-farm income

Category	Measure	Shrimp farm income	Non-farm income
Small farmers	G	0.31	0.44
Medium farmers	G	0.24	0.55
Large farmers	G	0.12	0.42
All farmers	G	0.36	0.49

Source: Field survey and author's estimation, 2014
Note: G=Gini coefficient

Expenditure on fingerlings, feed, and lime:

The results mean that the expenditures incurred on shrimp fingerlings (X_3) has exhibited positive and highly significant (1 percent level of significance) effects on shrimp production per farm (Y), whereas the effects of the variables namely feed expenditure (X_4) and lime expenditure (X_5) were also found positive and significant at 5 percent level and 1 percent level of significance respectively. It means that if expenditure on shrimp fingerlings, feed, and lime increases then the shrimp production also increases while other variables were kept unchanged. (Mondal, 2012) while studying the comparative economics on golda and bagda shrimp in Khulna region found coefficient of lime negative but insignificant and found feed cost positive and highly significant. But Feroz (2009) observed the coefficient of lime positive and significant while studying in Satkhira district on shrimp farming.

Expenditure on fertilizer:

The expenditures incurred on fertilizer has exhibited positive but insignificant. The reason behind this insignificancy may be that the farmers in the study area were not interested in using fertilizer. While Feroz (2009) showed the fertilizers positive and significant differently (Urea & TSP) but in this study expenditure on fertilizers were shown together.

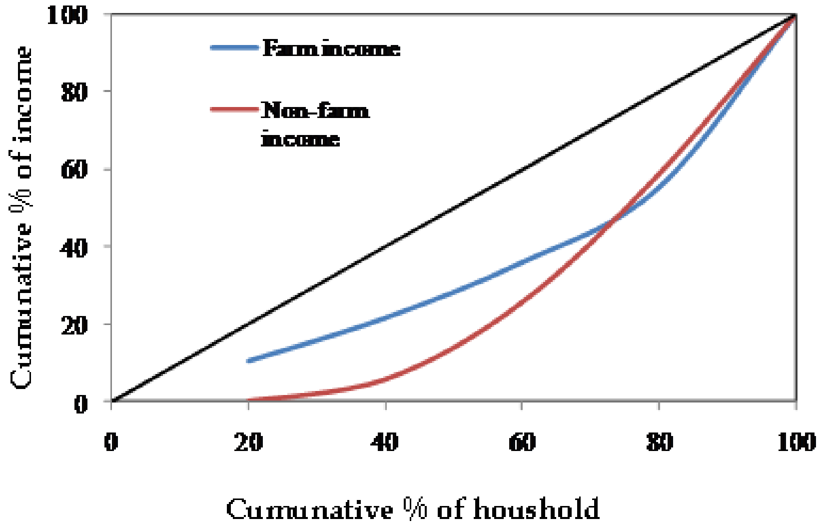

Figure 1. Lorenz curve for small farmers showing shrimp farm income and non-farm income

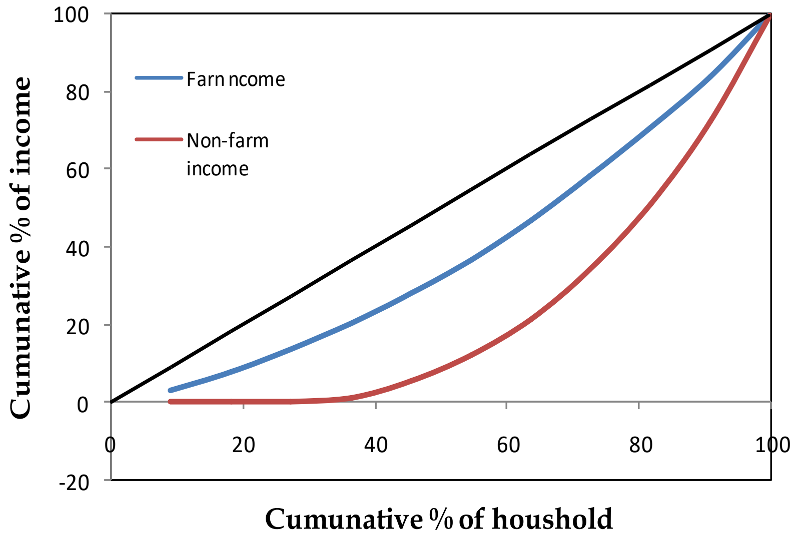

Figure 2. Lorenz curve for medium farmers showing shrimp farm income and non-farm income

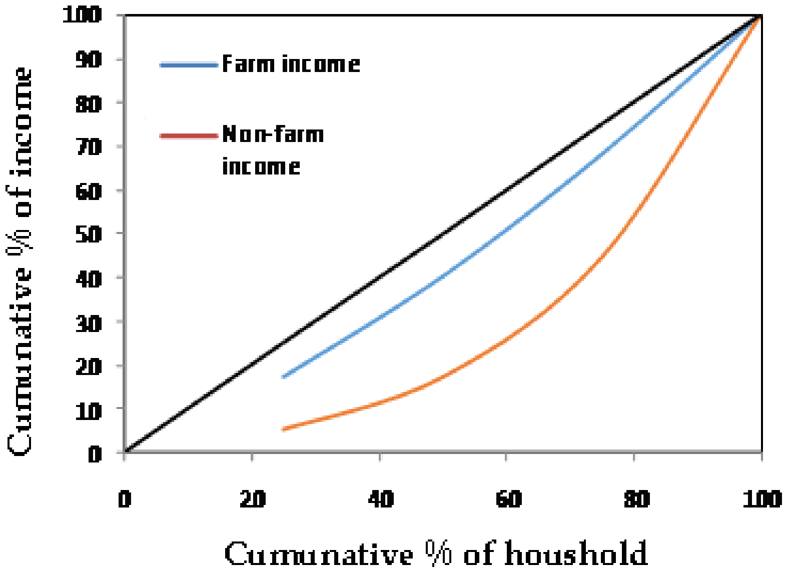

Figure 3. Lorenz curve for large farmers showing shrimp farm income and non-farm income

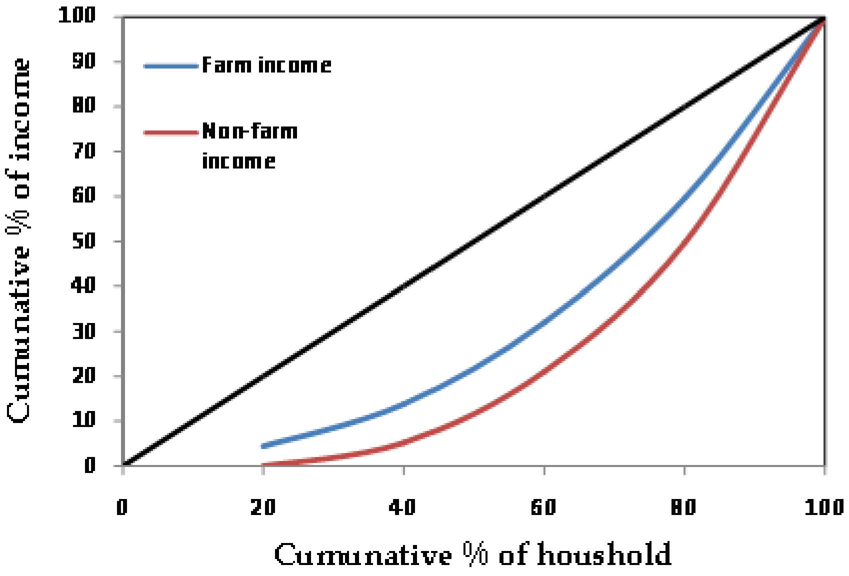

Figure 4. Lorenz curve for all farmers showing shrimp farm income and non-farm income

Education

The coefficient of education (X_7) is positive and highly significant at 1 percent level of significance effects on shrimp production per farm (Y). That means if farmers are more educated the production will increase more.

Expenditure on hired labor

The effects of the expenditure on hired labor were found negatively significant. It means that if hired labor cost increases the production will decrease. In the study area, most of the farmers liked to work themselves than to hire labor. Singh (2007) found hired labor negatively significant while studying on Fish production in west Tripura (India). Singh et al. (2001) while studying the dynamics of fish production in North Bihar (India) found the coefficient of human labor negative but non-significant.

Training

The effect of training on shrimp production was found highly positively significant in the study area. Trained farmers produced more shrimp than the non-trained farmers in the study area. The variables entered in the regression analysis in the case of all farmers explained 78.47 percent of the variation in the dependent variable. The F-value means that the explanatory variables included in the model were important for explaining the variation in the total production of shrimp farming.

The marginal and average physical productivities (MPPx&APPx) of the determinants of shrimp production along with their elasticity of production (Ep) in the study area have been given in Table 5. The production elasticity, which is equal to the ratio of MPPx and APPx were found positive but less than zero for all the inputs entered in the regression analysis except education, pond area, and pond age. This implied that the farmers were operating in the second stage of production concerning these inputs. The return to scale was 2.6197 which indicated that the production exhibited increasing returns to scale. This means that, if all the variables specified in the model were increased by 1 percent, gross returns would also increase by 2.6197 percent.

From the above discussion, it may be concluded that expenditure on shrimp fingerling, feed, lime, education, and hired labor were the important determinants of shrimp production in the study area. However, their effects on the different fish production varied across the category. Such type of findings of factors or determinants on shrimp production was found in most of the researches on shrimp in Bangladesh. Such as Uddin (1995), Uddin (1998), Miah (2001), Rahman (2003), Feroz (2009) and Mondal (2012). Besides, Such types of findings have also been made by Yadav (1990), Mollah et al. (1991), Awoyemi et al. (2003) and Singh (2007) while studying the input-output relationship in fish production in Bangladesh, Nepal, Nigeria, and India respectively.

Effects of Shrimp Production on Family Income Inequality

The Gini coefficient is a measure of inequality of a distribution. It is defined as a ratio with values between 0 and 1: the numerator is the area between the Lorenz curves of the distribution and the uniform distribution line; the denominator is the area under the uniform distribution line. It was developed by the Italian statistician Corrado Gini and published in his 1912 paper "Variabilità e mutabilità" ("Variability and Mutability"). The Gini index is the Gini coefficient expressed as a percentage and is equal to the Gini coefficient multiplied by 100. (The Gini coefficient is equal to half of the relative mean difference.)

The Gini coefficient is often used to measure income inequality. Here, 0 corresponds to perfect income equality (i.e. everyone has the same income) and 1 corresponds to perfect income inequality (i.e. one person has all the income, while everyone else has zero income).

Keeping in view the advantages and usefulness of the approach of the Gini coefficient, the same has been utilized to meet out the objectives of the present study. The mathematical form of the approach is:
Where G indicates Gini value, X_k are the proportion or share of households and Y_k are the proportion of their corresponding income. Always the value of the Gini coefficient is taken positive.

Table 6 shows the value of the Gini coefficient (indicates inequality) of shrimp farm income and non-shrimp farm income of the shrimp farmers' family. It was found that in the case of shrimp farm income small, medium and large farmers were equally distributed and all farmers were also equal in non-farm income. In the case of shrimp farm income, the highest Gini value was 0.36 (for all farmers) and lowest 0.12 (for large farmers) whether Haque (2011) found 0.81 for highest and 0.29 for lowest Gini value while she was studying on efficiency and institutional issues of Shrimp farming in Bangladesh. Again, in case of incomes that did not come from shrimp production among the shrimp farmers small and large farmers were relatively equally distributed while medium farmers were relatively in unequal distribution. The highest value of the Gini coefficient has been found 0.55 (for medium farmers) and the lowest is 0.42 (for large farmers) in case of shrimp non-farm income. The Lorenz curves have been shown in the case of shrimp farm income and non-farm income in the following figure 1,2, 3, and 4 among the small, medium, large and all farmers in the study area.

Table 7. Measurement of Inequality of Income from Other Sources

Category	Measure	Rice production	Vegetable production	Shop	Poultry farm	Pigeon farm	Banana	Other fish	Business	Day labor	Rickshaw puller
Small	G	0.76	0.80	0.8	0	0.8	0.8	0.8	0.73	0.8	0.8
Medium	G	0.70	0.91	0.91	0	0.91	0	0.76	0.87	0	0.91
Large	G	0.55	0	0.67	0.75	0	0.75	0.75	0.75	0.8	0
All	G	0.68	0.80	0.8	0.8	0.8	0.8	0.82	0.8	0.8	0.8

Source: Field survey and author's estimation.2014.
Note: G=Gini coefficient

Table 7 shows the value of the Gini coefficient (indicates inequality) of income of shrimp farmers from other sources. Other sources include rice production, vegetable production, shop, poultry farm, pigeon farm, banana production, other fish culture, business, day labor, a rickshaw puller, etc. It was found that in the case of vegetable production, pigeon farm, and rickshaw puller the large farmers were equally distributed. In the case of poultry farm, banana production, and day labor the medium farmers were equally distributed and in the case of poultry farm, small farmers were equally distributed in income. But in the study area, it does not mean that all farmers who had equal income distribution had same income from those sources. It means that there were no farmers in the selected category (who had equal income) in the study area. Most of the farmers of all categories had unequal income distribution from different sources. Among them, large farmers had relatively unequal income in the case of rice production and shop where all farmers were relatively unequally distributed in case of rice production.

All farmers in the study area had equal income from shrimp production. It was also seen that most of the farmers had relatively equal income from the non-shrimp farm. It means that most farmers had income from other sources along with shrimp production. They had more than one source of income besides the shrimp production. But sources differed from each farmer for that it was found unequal distribution among different sources.

CONCLUSION

The findings concluded that expenditure on shrimp fingerling, feed, lime, education, and hired labor were the important determinants of shrimp production in the study area. These determinants have strong effects on shrimp production as these were significant. If the value of R^2 is high then, the goodness of fit of the model is better which is applicable for this study. The F-value for the shrimp farming model was significant which means that the explanatory variables included in the model were important for explaining the variation in gross return of shrimp production. All farmers in the study area had equal income from shrimp production. It was also seen that most of the farmers had relatively equal income from the non-shrimp farm. It means that most farmers had income from other sources along with shrimp production. They had more than one source of income besides the shrimp production. But sources differed from each farmer for that it was found unequal distribution among different sources. Since this study was conducted in only one Upazila and data from 45 shrimp farmers which are a very small part of the population, so findings may vary according to space; for that reason findings of the study should be considered very carefully.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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