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Impact of Education on Rice Production in the Northern Districts of Bangladesh: A Ridge Regression Analysis

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Abstract *This study examines the impact of education on rice production in the northern districts of Bangladesh. The study employed farm level cross sectional data from the village of Chapachil of Shibganj Upazila of Bogra. The data used were collected by employing random sampling technique. The chi-square test and the econometric techniques of ordinary least squares (OLS) and ridge regression methods are used to access the impact of education on rice production. The results of the study show that education has a statistically significant and positive effect on rice production. The study also shows that input cost, labour cost, cultivable land and extension service have statistically significant and positive effect on rice production. The policy suggestion of the study is that government should put emphasis on education through literacy campaign, training and adult education programs so that rice production is increased. In addition, government should take initiative so that the farmer can easily adopt modern agricultural inputs.*

1. Introduction

Farmer's education is an important factor of rice production. Educated farmers can catch up new technology as well as modern inputs rapidly. Rice is the main

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and most dominant food crop. It provides 47.5 percent of rural employment (Bangladesh Economic Review, 2013). More than 95% of population consume rice and it alone provides 76% of calorie and 66% of total protein requirement of daily food intake (Bhuiyan *et al.,* 2002). About 77% area of arable land is used for rice production of Bangladesh (IRRI, 2012). Bangladesh needs to import rice almost every year as it faces a deficit of rice. In 2011-12 FY, the total import of rice through public and private sectors was 5.23 lakh metric tons (Bangladesh Economic Review, 2012). This deficit can be overcome by enhancing the productivity of rice. Rice productivity can be obtained both through technological improvement and efficiency improvement. Most of the farmers in our country are illiterate and live on subsistence farming. As a result, their income level is very low compared to other developing countries. So, it is difficult for them to gear up their income without education. Owing to lack of work-based education, the education arena has not so developed in Bangladesh. Although rice production is the main stream of her economy, education for scientific method of rice production is still felt necessary in this country. Education is an indispensable element for economic and social progress (Dev et al.1995). Most of the people live in rural areas and maintain their livelihood from the cultivation of rice. Rice cultivation also provides a safety net for the poor. Given the importance of rice in Bangladesh, this study focuses on the impact of education on rice production.

1.2 Review of Literature

A number of studies have assessed the relation between education and agricultural production (Wu, 1977; Lockheed et al.,1980; Jamison & Lau,1982; Philips, 1987; Hassan et al., 2003; Minh-Phuong, 2006); Onphanhdala,2009;Yasmeen et al.,2011; Girgin,2011; Rehman et al.2012). A number of other studies have assessed the impact of education on agricultural production (Singh, 1974; Welch, 1970; Pudasaini, 1983). There are yet other studies that have assessed the impact of education on rice production (Asadullah & Rahman, 2006; Salehin et al, 2009; Haq, 2012; Nargis & Lee, 2013; Duraisamy, 1989) in national and international arena. Asadullah and Rahman (2006) found that the different level of education has a positive and significant effect on rice production in Bangladesh. They found that the primary and secondary level of education is more relevant in rice production than tertiary level. Salehin et al. (2009) found that the education of the farmers has a significant and positive effect on rice production in Bangladesh. They also found that educated farmers are likely to be more receptive to the modern facts and ideas. Haq (2012) showed that primary education has positive value and its impact on rice productivity is significant. He found that farmers with primary education seem effective for rise per unit of rice productivity in Bangladesh. He also found that the farmers, who have only primary school degree, might spend enough time for farm production. Nargis and Lee (2013) found that education has a statistically significant and positive effect on rice production in Bangladesh. They also found that farmers who are more educated are likely to be more efficient compared to their less-educated counterparts, perhaps because of their better skills, access to information, and good farm planning. Duraisamy (1989) found that education has a positive and significant effect on rice production in India. He found that education expands the probability of adoption of modernization in new techniques in rice production. He found that the higher level of education is required to better understand, make out new information and utilise it in an effective way. He also found that the level of using high-yielding rice varieties in India was positively related to level of education. Dominique van de Walle (2003) studied the impact of education on rice production in Vietnam. Three major results come out of that study. First, education of the household head and other family members makes a significant contribution to farm profitability. Second, there also seem to exist important complementarities between education and irrigation, thereby giving some indication that education does help Vietnamese farmers make better use of agricultural technology, and third, primary education, but not higher levels of education, has significant impact on farm profitability. Years of schooling are found to have a significant impact on rice productivity, even though it is a small one.

Most of the studies included aggregate level of education, input cost, cultivable land, family labour and extension service as explanatory variables. But most of them did not include hired labour cost. The general forms of Cobb-Douglas production function were used in most of the studies. These studies have examined the effect of education on agricultural production as well as rice production through ordinary least squares model. They did not explain the pitfalls of their model. To have a clear picture of the impact of education on rice production in the northern districts of Bangladesh, it is necessary to make a deeper enquiry. Disaggregate level of education is used as explanatory variable rather than aggregate level of education in this study. The shortcomings of the classical linear regression model have been discussed systematically in this study. As a result, the findings of the study can be expected to be more reliable and valid than other studies. In this study, the ridge regression was applied to overcome the multicollinearity problems. To our knowledge, the study is the first of its kind in Bangladesh.

The objective of this study is to analyse the impact of education on rice production in the northern districts of Bangladesh by using ridge regression. The rest of the paper is structured as follows: Methodology and data of the study is presented in Section 2. The results and discussion are presented in Section 3. Finally, summary and policy implications are presented in Section 4.

2. Methodology of the Study

2.1 Selection of the Study Area

Shibganj Upazila of Bogra district was purposively selected as the study area for the study. The Shibgonj upazila comprises of 409 villages (BBS, 2012). The villagers primarily rely on agriculture activities, of which rice is the main agricultural crop in this upzila. That is why Shibganj was selected for the study. In addition, rice production of this upazila is higher than other upazilas of Bogra district (BBS, Bogra, 2012).

2.2 Methods of Data Collection

The study was based on primary and secondary data. The primary data were collected by using a structured questionnaire. Before preparing and applying the questionnaire to the final survey, pre pilot and pilot survey were done. The pre pilot survey was carried out through the Agricultural Office of Shibganj, concerned Sub-Assistant Agriculture Officer (SAAO), and academics. The pilot survey was conducted during November to December 2012. Afterwards, the final survey was carried out during December 2012 to January 2013.

Secondary data were collected from various issues of Bangladesh Economic Review, Agriculture census, Department of Agriculture Extension (DAE), and Bangladesh Bureau of Statistics (BBS).

2.3 Sampling Technique of the Study

An up-to-date list of all farmers of the selected village were collected from Upazila Agriculture Office. The list consists of 306 farmers, which constituted the population. In this study, random sampling technique was employed to collect the data. The numbers of farm household were selected randomly by using determination of sampling formula (Krejcie and Morgan, 1970) for regression analysis. Thus, the sample size was 171.

2.4 Empirical Theory and Method

The modified model of Jamison and Lau (1982) was utilized in this study.

$$Y = AK_i^{\beta_1} L_i^{\beta_2} T_i^{\beta_3} e^{\beta_4 D_1 + \beta_5 D_2 + \beta_6 D_3 + \beta_7 D_4 + DExt + \mu_i} \qquad (1)$$

Equation (1) provides nonlinear relationship between output and inputs. So, the nonlinear relationship can be linearized by both side natural logarithms (ln). So, the fitted model of this study is as follows

$$\ln Y = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \beta_3 \ln T_i + \beta_4 D_1 + \beta_5 D_2 + \beta_6 D_3 + \beta_7 D_4 + DExt + \mu_i ....(2)$$

where,

Y_i = total output of rice, K_i = input cost, L_i = labour cost ,T_i = cultivable land
D_1 = 1primary education of the farmer
= 0 otherwise
D_2 = 1secondary education of the farmer
= 0 otherwise
D_3 = 1 higher secondary education of the farmer
= 0 otherwise
D_4 = 1 tertiary education of the farmer
= 0 otherwise
Ext = extension service
D = 1 if taken extension service
D = 0 otherwise
μ_i = error term

The error term is assumed random and serially independent having zero mean with finite variance. In order to determine the appropriate technique of estimation, the empirical model is estimated by the ordinary least squares (OLS) method.

2.5 Definition of the Variables and Research Hypothesis

Output

Output is defined as the physical output of rice per decimal. Physical output is defined as the total production of rice cultivated area. It is expressed in terms of kilogram per decimal.

Input Cost

Input cost is defined as the sum total of expenditures on seeds, seedbed preparation, plough units, irrigation, organic and inorganic fertilizers, insecticides, fungicides, herbicides, harvesting and threshing cost.

Null hypothesis H_0: There is no relation between input cost and rice production.

Alternative hypothesis H_1: There is a relation between input cost and rice production.

Labour Cost

Labour unit is measured in man-days of eight hours. There are two types of labour cost in rice production. One hired labour cost and another family labour cost. Labour cost consists of these two types.

Null hypothesis H_0: There is no relation between labour cost and rice production.

Alternative hypothesis H_1: There is a relation between labour cost and rice production.

Cultivable Land

Cultivable land that is used by ploughing, sowing, and raising crops is expressed as decimal.

Null hypothesis H_0: There is no relation between cultivable land and rice production.

Alternative hypothesis H_1: There is a relation between cultivable land and rice production.

Education

Year of schooling may be represented as a level of education. It is defined as the number of academic years that a person has taken his/her lesson in educational institutions in this study. Level of education can be divided into five categories. These are illiterate, primary, secondary, higher secondary and tertiary.

Null hypothesis H_0: There is no relation between education and rice production.

Alternative hypothesis H_1: There is a relation between education and rice production.

Illiterate

People who can neither read nor write are be defined as illiterate. Illiterate also refers to someone who has not had any formal education at all.

Null hypothesis H_0: There is no relation between illiterate person and rice production.

Alternative hypothesis H_1: There is a relation between illiterate person and rice production.

Primary Education

Primary education consists of five years of formal schooling. Person who obtained primary education from a formal or informal school is called primary educated person.

Null hypothesis H_0: There is no relation between primary education and rice production.

Alternative hypothesis H_1: There is a relation between primary education and rice production.

Secondary Education

The secondary level of education comprises of five years of formal schooling.

Null hypothesis H_0: There is no relation between secondary education and rice production.

Alternative hypothesis H_1: There is a relation between secondary education and rice production.

Higher Secondary

The higher secondary level of education is comprised of two years of formal education.

Null hypothesis H_0: There is no relation between higher secondary education and rice production.

Alternative hypothesis H_1: There is a relation between higher secondary education and rice production.

Tertiary Education

Tertiary education is defined as people who hold education more than higher secondary level. Tertiary education is normally taken to include undergraduate and postgraduate education as well as vocational education and training.

Null hypothesis H_0: There is no relation between tertiary education and rice production.

Alternative hypothesis H_1: There is a relation between tertiary education and rice production.

Extension Service

The contact between agriculture extension agents or officers and farmers is introduced as a measure of the availability of information about new and improved inputs. It is measured in dummy variable.

Null hypothesis H_0: There is no relation between extension service and rice production.

Alternative hypothesis H_1: There is a relation between extension service and rice production.

2.6 Regression Analysis

As the main objective of this study is to assess the impact of education on rice production, for achieving this objective cause-effect analysis is suitable. In doing so, regression analysis has been applied in this study. Regression analysis has become one of the most widely used statistical tools for analyzing multifactor data. It is appealing because it provides a conceptually simple method for investigating functional relationship among variables.

2.6.1 Ridge Regression

Ridge regression provides another alternative estimation method that may be used to advantage when the predictor variables are highly intercorrelated. There are a number of alternative ways to define and compute ridge estimates. Ridge estimates of the regression coefficients may be obtained by solving a slightly altered form of the normal equations. Hoerl and Kennard (1970) suggested the ridge regression as an alternative procedure to the OLS method in regression analysis, especially, when multicollinearity exists.

The addition of a small positive number k to the diagonal elements of XX causes XX to be non-singular. Therefore, the ridge solution is given by:

$$\hat{\beta}_R = (X'X + kI)^{-1} X'Y, k \geq 0 \tag{3}$$

Where k is ridge parameter and I is identity matrix. Values of k lie in the range (0, 1). When k = 0, the ridge estimator becomes as the OLS.

From equation (3), by taking expectation on both sides, $E(\hat{\beta}_R) = A_k \beta$

where $A_k = \left[I + k(X'X)^{-1}\right]^{-1}$

and $Var\left(\hat{\beta}_R\right) = \hat{\sigma}^2 A_k (X'x)^{-1} A_k'$

The ridge estimator $\hat{\beta}_R = \left[I + k(X'X)^{-1}\right]^{-1}\hat{\beta}$ is a linear transformation of the OLS. The sum of the squared residuals is an increasing function of *k*. The mean squares error of ridge estimator is given by:

$$MSE\left(\hat{\beta}_R\right) = E\left[\left(\hat{\beta}_R - \beta\right)'\left(\hat{\beta}_R - \beta\right)\right] = \hat{\sigma}^2 trace\left[A_k(X'X)^{-1}A_k'\right] + \hat{\beta}'(I - A_k)'(I - A_k)\hat{\beta}$$

$$\hat{\sigma}^2\sum_{i=1}^{p}\frac{\lambda_i}{(\lambda_i + k)^2} + k^2\hat{\beta}'(X'X + kI)^{-2}\hat{\beta} \qquad (4)$$

Where, $\lambda_1, \lambda_2, \ldots\ldots\lambda_p$ are the eigenvalues of XX and the first term of the right hand in equation (4) is the trace of the dispersion matrix of theβ_R and the second term is the square length of the bias vector. There always exists a $k > 0$, such that β_R has smaller MSE than β_R this means $MSE\left(\hat{\beta}(k)\right) < MSE(\hat{\beta})$ that. It indicates that ridge estimator performs better than the OLS estimator. Ridge regression model provides better and valid results than ordinary least squares when the multicollinearity problem exists. This is because it has smaller MSE of estimators, smaller variance for most estimators than OLS.

3. Results and Discussion

The impact of education on rice production was examined by using descriptive and inferential statistics. *Chi square* test is applied to assess the association between level of education and rice production. Regression analysis is employed to estimate the impact of education on rice production in the study area. Both quantitative and dichotomous variables are employed as explanatory variables in this study.

3.1 Descriptive Statistics

Table 3.1 shows the variables that are used in estimations and their sample statistics, namely maximum and minimum values, mean and standard deviation.

Table 3.1 : Descriptive Statistics of the Variables

Item	No. of cultivators	Minimum	Maximum	Mean	Standard Deviation
Output (Kg)	171	1300.00	6375.00	3289.7953	1369.35948
Yield (kg)	171	18.18	24.75	22.3989	1.58658
Input cost (Tk.)	171	3550.00	18000.00	9645.5205	4312.40019
Input cost(Tk.) per decimal	171	46.98	74.81	64.9354	7.74889
Labour cost (Tk.)	171	2850.00	15500.00	7672.4269	3588.58535
Labour cost (Tk.) per decimal	171	41.13	60.98	51.3738	6.16396
Cultivable land (decimal)	171	66.00	272.00	147.6462	62.62810
Education (years of schooling)	171	.00	16.00	6.2807	4.61616
Extension service (percentage)	Yes=52.6 No=47.4				

Source: *Field survey, December 2012 and January 2013*

The mean, standard deviation, minimum and maximum of the variables are presented in Table 3.1. In Table 3.1, it is found that the average yield of rice is 22.39 kilograms with maximum average yield of 24.75 kilograms and minimum average yield of 18.18 kilograms. The average value of input cost is 64.93 Tk. with maximum and minimum average value of input cost being 74.81 Tk. and 46.98 Tk., respectively. The average value of labour cost is 51.37 Tk. and the maximum and minimum average value of labour cost are 60.98 Tk. and 41.13 Tk., respectively. The average of cultivable land is 147.64 decimal with the maximum and minimum of the cultivable land being 272 decimal and 66 decimal, respectively. The average level of education of the respondent is 6.28 years and the standard deviation of the education level of the respondent is 4.61 years. Maximum education level of the respondent is 16 years and minimum is 0.00 years. Maximum and minimum education level shows a wide variation of the respondents. About 52.6% respondents of the study area take agricultural extension service from Sub Assistance Agriculture Officers and the rest 47.4% do not take any extension service.

3.2 Results of *Chi-Square* Test

Table 3.2 : Impact of Education on Rice Production in the Study Area

Yield (kg)	Illiterate	Primary	Secondary	Higher Secondary	Tertiary	Total
18-22	28	14	18	0	2	62
22-26	0	38	46	11	14	109
Total	28	52	64	11	16	171
$\chi^2 = 63.182$ df=4		p value =0.000				

Source: *Field survey, December 2012 and January 2013*

Table 3.2 shows the impact of education on rice production in the study area. In Table 3.2, the calculated value χ^2 of is 63.182 and the critical value of χ^2 for 4 degrees of freedom at 0.1% level of significance is 18.467. Since the calculated value of is greater than the tabulated value, the null hypothesis can be rejected. So, the alternative hypothesis is accepted at the 0.01% level of significance. It can be said that there is a relationship between the two variables. So, there is evidence of a relationship between rice production and education.

Table 3.3 shows the impact of illiterate farmers on rice production in the study area. In Table 3.3, the calculated value of is 58.864 and the critical value of for 1 degrees of freedom at 0.1 % level of significance is 10.827. Since 58.864 > 10.827, the null hypothesis can be rejected, and the alternative hypothesis

Table 3.3 : Impact of Illiterate Farmers on Rice Production

Yield(kg)	Illiterate	Others	Total
18-22	28	34	62
22-26	0	109	109
Total	28	306	171
$\chi^2 = 58.864$ df=1 p value =0.000			

accepted at the 0.1% level of significance. That is to say, there is relationship between the two variables. So, there is evidence of a relationship between rice production and illiterate farmer. This is because; the experience of the illiterate farmer is higher than others.

Table 3.4 : Impact of Primary Education on Rice Production

Yield(kg)	Primary level	Others	Total
18-22	14	48	62
22-26	38	71	109
Total	52	119	171
$\chi^2 = 2.817$ df=1 p value =0.093			

Table 3.4 shows the impact of Primary education on rice production. In Table 3.4, the calculated value of is 2.817 and the critical value of for 1degrees of freedom at 10% level of significance is 2.706. Since 2.817 > 2.706, the null hypothesis can be rejected, and the alternative hypothesis accepted. It can be said that there is a relationship between the two variables. At the 10% level of significance, there is evidence of a relationship between rice production and primary education.

Table 3.5 : Impact of Secondary Education on Rice Production

Yield(kg)	Secondary level	Others	Total
18-22	18	44	62
22-26	46	63	109
Total	64	107	171
$\chi^2 = 2.927$ df=1 p value =0.087			

Table 3.5 shows the impact of secondary education on rice production. In Table 3.5, the calculated value of is 2.927 and the critical value of for 1 degrees of freedom at 10% level of significance is 2.706. Since 2.927 > 2.706, the null hypothesis can be rejected, and the alternative hypothesis accepted. It can be said that there is a relationship between the two variables. At the 10% level of significance, there is evidence of a relationship between rice production and secondary level of education.

Table 3.6 : Impact of Higher Secondary Level of Education on Rice Production

Yield(kg)	Higher Secondary Level	Others	Total
18-22	0	62	62
22-26	11	98	109
Total	11	160	171
$\chi^2 = 6.687$ df=1 p value = 0.010			

Table 3.6 shows the impact of higher secondary education on rice production. In Table 3.6, the calculated value of is 6.687 and the critical value of for 1 degrees of freedom at

1% level of significance is 6.635. Since 6.687 > 6.635, the null hypothesis can be rejected, and the alternative hypothesis accepted at the 1% level of significance. That is to say, there is a relationship between the two variables. So, there is evidence of a relationship between rice production and higher secondary level of education.

Table 3.7 : Impact of Tertiary Level of Education on Rice Production

Yield(kg)	Tertiary level	Others	Total
18-22	2	60	62
22-26	14	95	109
Total	16	155	171
$\chi^2 = 4.311$ df=1 p value =0.038			

Table 3.7 shows the impact of tertiary level education on rice production in the study area. In Table 3.7, the calculated value of is 4.311 and the critical value of for 1 degrees of freedom at 5 % level of significance is 3.841. Since 4.311 > 3.841, the null hypothesis can be rejected, and the alternative hypothesis accepted at the 5% level of significance. That is to say, there is a relationship between the two variables. So, there is evidence of a relationship between rice production and tertiary level of education.

3.3 Empirical Results

The empirical results of the production function in equation (2) are presented in Table 3.8.

In Table 3.8, the findings show that the input cost of production is insignificant and the coefficient of input cost of production is 0.032771. The result indicates that as input cost of production increases by Tk.1, output increases by

Table 3.8 : Empirical Results of Multiple Regressions

	β	St. Error	t	P value	Eigenvalue	Tolerance	VIF
1	2	3	4	5	6	7	8
Intercept	2.847009*	0.0648	43.88	0.0000	5.4638	-	-
Input cost(k)	0.032771	0.0282	1.15	0.2482	1.0169	0.019984	50.039
Labor cost(L)	0.027	0.0290	0.93	0.3536	1.0000	0.018422	54.282
Cultivable Land(T)	0.915301*	0.0178	51.36	0.0000	1.0000	0.059205	16.890
Primary(D_1)	0.119952*	0.0062	19.24	0.0000	0.4138	0.413936	2.4158
Secondary(D_2)	0.130672*	0.0061	21.22	0.0000	0.1017	0.383374	2.6084
Higher Secondary(D_3)	0.129498*	0.0095	13.59	0.0000	0.0034	0.622866	1.6054
Tertiary(D_4)	0.147132*	0.0082	17.81	0.0000	0.0001	0.588664	1.6987
Extension Service(S)	0.059834*	0.0044	13.52	0.0000	0.00002	0.697991	1.4326
R^2		0.9968					
Adjusted R^2		0.9967					
Mean square error		24.62					
d Statistic (DW)		2.027					

Source: *Field survey, December 2012 and January 2013; * Highly significant*

0.032771kilogram. The labour cost of production is statistically insignificant. The coefficient of labour cost of production is 0.027. The result indicates then if the labour cost of production increases by Tk.1, then the total output increases by 0.027 kilogram. The cultivable land is statistically highly significant. The coefficient of cultivable land is 0.915301.The result indicates that it the cultivable land increases by 1 decimal, total production increases by 0.915301kilogram per decimal.

The coefficient of illiterate farmer is 2.847009, which is highly significant. This is because, if the farmers' experience increases, their total output increases. In this study, the level of experience is the highest for illiterate rice farmers. The coefficient of primary education is (2.847009+0.119952) = 2.966961, which is highly significant. It indicates that if the primary education of farmer increases, their total output increases by 2.966961 kilogram. The coefficient of secondary education is (2.966961+0.130672) =3.097633, which is highly significant. If the secondary education of farmers increases, their total output increases by 3.097633 kilogram. The coefficient of higher secondary education is (3.097633 +0.129498) =3.227131, which is highly significant. If the higher secondary education of farmer increases, their total output increases by 3.227131kilogram. The coefficient of tertiary education is (3.227131+0.147132) =3.374263, which is highly significant. If the tertiary education of farmer increases, their total output increases by 3.374263 kilogram. The coefficient of extension service is 0.059834 and it is statistically significant. It indicates that if the extension service increases, the farmers' total output increases by 0.059834 kilogram.

Two variables of this model provide insignificant results. So, this model might suffer from multicollinearity problem. In Table 3.8, the value of *d* statistic is 2.027, which indicates that there is no serial correlation.

3.4 Reliability and Validity

To ensure the reliability of the questionnaire Cronbach's alpha test has been used in this study. The result of Cronbach's alpha test is given in Table 3.9.

Table 3.9: est of Reliability

Number of observation	Number of items	Standardized item Alpha	Cronbach`s Alpha
171	6	0.8062	0.8429

Table 3.10 : Empirical Results of Ridge Regression

	$\hat{\beta}$	St. Error	t	P value	Tolerance	VIF
1	2	3	4	5	6	7
Intercept	1.715819*	0.190249	9.018802	0.000	-	-
Input cost(K)	0.222939*	0.039048	5.709343	0.000	0.217717	4.593127
Labor cost(L)	0.224985*	0.038826	5.794679	0.000	0.213802	4.677222
Cultivable Land(T)	0.44686*	0.039804	11.22639	0.000	0.246412	4.05825
Primary (D1)	0.072477*	0.022547	3.214494	0.001	0.657046	1.521962
Secondary (D2)	0.084083*	0.022021	3.818307	0.000	0.622419	1.606635
Higher Secondary(D3)	0.060732***	0.036708	1.654468	0.099	0.871558	1.147371
Tertiary (D4)	0.101578*	0.031483	3.226416	0.001	0.840842	1.189284
Extension Service	0.050183**	0.017467	2.873032	0.004	0.929315	1.076061
R^2	0.9670					
Adjusted R^2	0.9351					
Mean square error	2.20					
k(Ridge parameter)	0.13000					

Source: *Field survey, December 2012 and January 2013*

* Highly significant **5% level of significant***10% level of significant

In Table 3.9, it is observed that Cronbach`s alpha is 0.8429, which indicates a high level of internal consistency for our scale with this specific sample.

In this study, variables and questions are drawn from literature, which ensured the validity of the questionnaire (Ali and Noman, 2013).

3.5 Results of Ridge Regression

Ridge regression has been applied to overcome the problem of multicollinearity. The ridge regression results are shown in Table 3.10.

All VIF values are less than 5 which is shown in Table 3.10. These results indicate that this model is free from multicollinearity problems. It also shows the different results between Table 3.8 and Table 3.10. All variables are statistically significant in Table 3.10.

The coefficient of input cost of production is 0.222939 and it is statistically highly significant. The results indicate that as input cost of production increases by Tk.1, output increases by 0.222939 kilogram. The same results in line with Appleton & Balihuta (1996) and Weir (1999).

The coefficient of labour cost of production is 0.224985 it is statistically highly significant. The results indicate that if the labour cost of production increases by Tk.1, then output increases by 0.224985 kilogram. The findings were consistent with studies by Cotlear (1986), Appleton & Balihuta (1996), Yang (1997) and Weir (1999).

The coefficient of cultivable land is 0.44686 and is statistically highly significant. The result indicates that it the cultivable land increases by 1 decimal, total production increases by 0.44686 kilogram per decimal. The same results were found by Cotlear (1986), Appleton & Balihuta (1996), Yang (1997), Weir (1999) and Rehman et al. (2012).

The coefficient of illiterate farmer is 1.715819, which is highly significant. This is because, if the farmers experience increases, their total output increases. In this study, the level of experience is high of illiterate rice farmers.

The coefficient of primary education is (1.715819 +0.072477) = 1.788296, which is significant. It indicates if the primary education of farmer increases, their total output increases by 1.788296 kilogram. The similar results were found by Singh (1974), Dominique van de Walle (2003),Onphanhdala (2009) and Haq(2012).

The coefficient of secondary education is (1.788296+0.084083) =1.872379, which is highly significant. If the secondary education of farmer increases, their total output increases by 1.872379 kilogram. The similar results were found by Singh (1974) and Asadullah & Rahman (2006).

The coefficient of higher secondary education is (1.872379+ 0.060732) =1.933111, which is significant. If the higher secondary education of farmer increases, their total output increases by 1.933111 kilogram. The similar result was found by Pudasaini (1983).

The coefficient of tertiary education is (1.933111 + 0.101578) =2.034689, which is highly significant. If the tertiary education of farmer increases, their total output increases by 2.034689 kilogram. The similar results were found by Pudasaini (1983) and Gemmell (1996).

The coefficient of extension service is 0.050183 and it is statistically significant. The results indicate that as the extension service increases, total production increases. This means that greater extension contacts between extension agents and farmers lead to higher productivity. Similar results were found by Huffman (1974), Haq (2011) and Nargis & Lee (2013).

3.6 Fit of the Model

The analysis of variance of ridge regression in Table 3.11 summarizes how much of the variance in the data (total sum of squares) is accounted for by the factor effect (factor sum of squares) and how much is random error (residual sum of squares). In Table 3.11, F value is 291.9985 and the overall results are highly significant.

Table 3.11 : Analysis of Variance of Ridge regression

	Sums of Squares	df	Mean Squares	F	P value
Regression	28.23563	8	3.529454	291.9985	0.000
Residual	1.958131	162	0.012087		
Total	30.19376	170			

We have tried to justify that ridge regression is better than OLS method. Table 3.8 shows the results of OLS. In Table 3.8, coefficient of determination (R-square) is 0.9968, adjusted R^2 is 0.9967. The 2nd column of Table 3.8 shows the OLS estimator of, Eigen values shown in column 6th, and VIF is in column 8th. Here maximum VIF is 54.282, which indicates greater multicollinearity. We also see that R-square and adjusted R-square are very high, and least squares estimates are unstable. The predictor variables are correlated so we can apply ridge regression techniques to find a stable set of correlation.

Table 3.10 shows the results of Ridge Regression. In Table 3.10, the coefficient of determination(R-square) is 0.9670, adjusted R^2 is 0.9351, 2nd column shows the ridge estimator of, VIF is in column 7th.We also see that R-square and adjusted R-square are less than OLS, and ridge estimates are stable than OLS estimates.

We also find from Table 3.8 and Table 3.10, Than the tolerance of OLS estimates is less than the tolerance of ridge estimates. As a result, the VIF for ridge estimates is less than the VIF for OLS estimates. These results indicate that the ridge regression method is better than OLS as it is clear from Table 3.8 and Table 3.10.

We estimate using OLS estimator and estimate using ridge estimator with different choices of k from a grid (0.01, 0.02..., and 0.13). We compute mean square error for OLS estimator and mean square error for ridge regression estimator. In Table 3.8 and Table 3.10 MSE for OLS is greater than the MSE for ridge regression. This result indicates that ridge estimator performs better than the OLS estimator does.

4. Conclusions and Policy Suggestions

In this study, *Chi Square* test has been used to find out the association between yield of rice and level of education. The results show that there is a significant association between yield of rice and the level of education. The empirical analysis of impact of education on rice production in Bangladesh is discussed in this study. Impact of education on rice production is very important for policy formulation and strategies for the development of agriculture sector. In this study, multiple regression model and ridge regression model have been used to estimate the impact of education on rice production. In addition, the empirical findings of the multiple regressions show that most of the variables are highly involved in multicolinearity. In order to overcome this problem ridge regression has been used in this study. The empirical results of ridge regression reveal that the various levels of education have positive and statistically significant effect on rice production. Therefore, the rice production increases with the increases in the level of education of farmer. This result suggests that the level of education of farmer has positive effect on rice production. The input cost of production has positive effect on rice production. The labour cost, cultivable land and extension service have also positive effect on rice production. It is to be noted that the ridge regression models turn out better results than ordinary least squares method it the multicollinearity problem prevails in the model in the sense of smaller MSE of estimators, smaller variation for estimates.

The positive impact of education on rice production supports the hypothethis that education is indeed one of the key ingredients that enhances the productivity of rice. To boost up rice production in Bangladesh government should put emphasis on education so that the farmer can easily adopt modern agricultural inputs, pest and irrigation management. The literacy campaign, training and adult education programs should be undertaken so that the farmers become better off in short run as well as in long run.

Findings of the study confirm that most of primary educated people in the study area are involved in rice production. But there is no agro-oriented course or curricula in the Primary level schools or institutions. There are a few agricultural training institutions in our country. Agro based courses must be included in the primary level schools or institutions. In addition, the number of agricultural institutes must be increased throughout the country, which in turn will increase the number of people with agricultural knowledge. It certainly would have a positive impact on agricultural productivity.

At present in the secondary level an optional agricultural science subject or course is offered which in our view is very inadequate. Therefore, a compulsory course should be introduced in the secondary and higher secondary levels. We believe it will be help increase the number of people with agricultural knowledge. For agricultural technological development, emphasis should be given on research and development activities. For that purpose, setting up agricultural universities and research institutes should be given emphasis. Policy makers may need to consider other levels of education and training in formulation of policy, for example, undertaking training programmes on the production of crops, storage of crops, pest control and management, livestock rearing, development of indigenous skills, and changing food habit, all of which can contribute to enhancing food security in the country.

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