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**Research Note**

# EFFECT OF CREDIT ON YIELD GAP AND TECHNICAL EFFICIENCY OF BORO PADDY PRODUCTION IN A SELECTED AREA OF COMILLA DISTRICT

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## ABSTRACT

The study examines the effect of credit on yield gap and technical efficiency of Boro paddy production in the study area. The results indicated that credit receivers achieved higher amount of potential yield than the credit non-receivers. Mechanical power cost, irrigation cost, application of urea, application of MP and credit dummy had positive impact on reducing yield gap while human labor, TSP application and age had negative impact on reducing yield gap. Credit also showed positive impact on increasing technical efficiency. Technical efficiency was higher for credit receivers than the non receivers according to tenure status, age category, educational status, frequency of extension contacted.

## I. INTRODUCTION

Paddy is not only the main food item but also major energy source for the people of Bangladesh, but also the major source of cash income at present for a vast majority of the rural people. It is the most important food crop in terms of area, production and its contribution to national income and national economic development. In Bangladesh, as one of the lowincome countries in Asia, the small farmers mostly grow paddy. It is primarily grown to meet their home consumption. The country could no achieve production target properly because of low level of technological adoption and extension services.

The productive environmental parameters play a very important role as a resource in crop yield variation. Paddy, the most important crop in terms of area and production, plays leading role in improving food security in the country.

Yield variation is one of the chromic problems of paddy production in Bangladesh. The concept of yield gaps comes from the country study carried out by the International Paddy Research Institute in the 1970s which make a quantitative differences between the potential yield and actual paddy yield (Gomez *et al.*, 1979). The estimates of paddy yield obtained in on-farm trial and the farmer's field for different ecosystems is presented as the yield gap.

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The important factor behind this gap could be that the poor farmers may forgo the suboptimum investment in agricultural inputs because of the high risk in paddy cultivation under low land conditions. It implies that there is ample scope for increasing yield through crop management practices under such environments.

Considering above-mentioned reasons, this study was concerned with the investigation of the effect of credit on yield gap reduction and increasing technical efficiency. The need for development of agriculture sector has attracted the attention of policy makers and various steps were taken to increase agricultural production. Among them, credit is one of the important factors influencing substantially the output of agriculture (Singh 2000). The researchers believe that the performance at farmers field of modem variety paddy is lower than their potential yield capacity.

Production may respond to the changes in the supply of credit only if the demand for input used in the production process, is influenced by the changes in the supply of credit. The supply of agricultural credit is less than its demand. Credit should be provided in adequate amount as well as in right time, so that farmers can use it for timely purchasing of essential inputs. The farmers can also take other necessary steps for proper technical assistantship, which may reduce the yield gap as much as possible. Singh and Pandey (1995), Yadav and Rahman (1994), Elahi (1990), Adesina and Djato (1996), Reddy et al. (1996), Reddy (1997) studied the impact of credit and technology on food grain production. It is necessary to show the impact of institutional credit on yield gap and technical efficiency of Boro paddy p'roduction in a selected area of comilla district. Thus the specific objectives of the study were: (i) to estimate the yield gap of credit receivers and non-receivers of paddy producers; (ii) to identify the factors behind the yield gap; (iii) to calculate the extent of technical efficiency and identify the factors behind the inefficiency of paddy production for both group of credit users and non-users.

## II. METHODOLOGY

### Selection of Samples and Sampling Techniques

After final selection of the study area, a list of credit receiver of village Neamatpur and Kamarchar was collected from the Bangladesh Krishi bank (BKB). The total number of loanees was found to be 40 in each village. Another list of credit non-receiver was also prepared for the two villages. A simple random sampling technique was applied to have required sample for the present study. Forty samples each from credit receiver and credit nonreceiver were selected randomly from the list of population prepared. Selected sample farmers were than classified into small, medium and large group. Farmers owning upto 1.00 hectare of land were grouped into small farmers, farmers owning 1.00 hectare to 3.00 hectares of land were classified as medium farmers and farmers owning more than 3.00 hectares of land were grouped into large farm category. BRRI Dhan 29 is generally sown/transplanted in late

December to early February and harvested in April-May. The period of data collection of the study was July 2001 to September 2001.

**Empirical Model for Finding the Effect of Different Factors on Yield Gap**

The major inputs used in production processes of MV Boro paddy (BRRI Dhan 29) in the study area were human labour, mechanical power, irrigation, seed, urea, TSP and MP. Nine explanatory variables were chosen to find out the quantitative effect on yield gap. The model is described below:

$$\ln Y = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + \beta_5 \ln(X_5) + \beta_6 \ln(X_6) + \beta_7 \ln(X_7) + \beta_8 \ln(X_8)$$

Where, Ln = Natural logarithm, Y= Yield gap (kg/ha), $X_1$ = Human labour/ha in man-days, $X_2$ = Mechanical power cost (Taka/ha), $X_3$ = Irrigation cost (Taka/ha), $X_4$ = Urea used (kg/ha), $X_5$ = TSP used (kg/ha), $X_6$ = MP used (kg/ha), $X_7$ = 1 if credit receiver, 0 otherwise, $X_8$ = Age measured in years.

**Stochastic Production Frontier and Technical Inefficiency Model**

Farrel's (1957) paper on efficiency measurement led to the development of several approaches to efficiency and productivity analysis. Among these, the stochastic frontier production (Aigner *et al.* 1977; Meeusen and van den Broeck 1977) and Data Envelopment Analysis (DEA) (Chames *et al.* 1978) are the two principal methods [see Coelli (1995a) and Coelli *et al.* (1998) for detailed information on efficiency measurement using the stochastic production frontier and DEA, including their strength, weaknesses, and estimation procedures]. As noted by Coelli *et al.* (1998), the stochastic frontier is considered more appropriate than DEA in agricultural applications, especially in developing countries, where the data are likely to be heavily influenced by the measurement errors and the effects of weather conditions, diseases, etc.

Thus following Aigner *et al.* (1977) and Meeusen and Van Den Broeck (1977), the stochastic frontier production function with two error terms can be modeled as:

$$Y_i = f(X_i, \beta) \exp(V_i - U_i) \text{ ..............(1)}$$

Where $Y_i$ is the production of the i-th farm (i = 1, 2, 3........... n), $X_i$ is a $(1 \times k)$ vector of functions of input quantities applied by the i-th farm, □ is a $(k \times 1)$ vector of unknown parameters to be estimated, $V_i$s are random variables assumed to be independently and identically distributed $N(0, \sigma^2_u)$ and independent of $U_i$s and the $U_i$s; and the $U_i$s are non-negative random variables, associated with technical inefficiency in production assumed to be independently and identically distributed (iid) and truncations (at zero) of the normal distribution with mean, $Z_i$□and variance $\sigma^{□}_u$ (|N $(Z_i\delta, \sigma^2_u)$|); $Z_i$ is a $(1 \times m)$ vector of firmspecific variables associated with technical inefficiency, and $\delta$ is a $(m \times 1)$ vector of unknown parameters to be estimated (Sharma and Leung, 1998).

Following Battese and Coelli (1995), the technical inefficiency effects, $U_i$ in equation (1) can be expresses as:

$$U_i = Zi\,\delta + W_i \text{ ..................................(2)}$$

Where $W_i$s are random variables, defined by the truncation of the normal distribution with zero mean and variance $\sigma^2_u$, such that the point of truncation is $-Z_I\,\delta$, i.e. $W_i \geq - Z_I\,\delta$. Besides the farm-specific variables, the $Z_i$ variables in equation (2) may also include input variables in the stochastic production frontier (1), provided that the inefficiency effects are stochastic. If Z-variables also include interactions between farm-specific and input variables, then a Huang and Liu (1994) non-neutral stochastic frontier is obtained.

The technical efficiency of the ith sample farm, denoted by $TE_i$ is given by:

$$TE_i = \exp(-U_i) = Y_i/f(X_{i,}\,\beta)\exp(V^i) = Y_i/Y_i \text{ .............................. (3)}$$

Where $Y_i = f(X_i, \beta) \exp(V_i)$ is the farm-specific stochastic frontier. If $Y_i$ is equal to $Y_i$ is equal to $Y_i$ then $TE_i = 1$, reflects 100% efficiency. The difference between $Y_i$ and $Y_i$ is embedded in $U_i$ (Dey *et al.,* 1999). If $U_i = O$, implying that production lies on the stochastic frontier, the farm obtains its maximum attainable output given its level of input. If $U_i < O$, production lies below the frontier an indication of inefficiency.

The maximum likelihood estimate (MLE) of the parameters of the model defined by equations (1) and (2) and the generation of farm-specific TE defined by (3) are estimated using the FRONTIER 4.1 package (Coelli, 1994). The efficiencies are estimated using a predictor that is based on the conditional expectation of exp (-U) (Battese and Coelli, 1993; Coelli, 1994). In the process, the variance parameters $\sigma^2_u$ and $\sigma^2_v$ are expressed in terms of the parameterization:

$$\sigma^2 = (\sigma^2_u+\sigma^2_v)\text{.......................................... (4)}$$

and

$$\gamma = (\sigma^2_u/\sigma^2_v)\text{ ............................................ (5)}$$

The value of □ ranges from 0 to 1 with values close to 1 indicating that the random component of the inefficiency effects makes a significant contribution to the analysis of the production system (Coelli and Battese, 1996).

### Empirical Model of Stochastic Frontier Production Function

Two types of production function namely Cobb-Douglas and translog dominate the technical efficiency literature. In this study it is assumed that the Cobb-Douglas is the appropriate form of the stochastic frontier production function. The stochastic production function for the sample farmers was specified as:

$$\ln Y_i = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + \beta_5 \ln(X_5) + \beta_6 \ln(X_6) + \beta_7 \ln(X_7) + \beta_8 \ln(X_8) + \beta_9 \ln(X_9) + \beta_{10} \ln(X_{10})$$

Where, Ln = Natural logarithm, Y= Observed farm output (kg/ha), $X_1$ = Human labour in man-days, $X_2$ = Mechanical power cost (Taka/ha), $X_3$ = Irrigation cost (Taka/ha), $X_4$ = Harvesting cost (Taka/ha), $X_5$ = Seed used (kg/ha), $X_6$ = Urea used (kg/ha), $X_7$ = TSP used (kg/ha), $X_8$ = MP used (kg/ha), $X_9$ = Land use cost (Taka/ha), $X_{10}$ = Interest on operating capital (Taka/ha)

The technical efficiency effects $U_I$ are defined as:

$$U_i = \delta_0 + \delta_j Z_I + W_I$$

Where, $Z_1$ = Credit dummy, $Z_2$ = Age of the respondent, $Z_3$ = Education of the respondent, $Z_4$ = Farm size, $Z_5$ = Extension contact, $W_i$ are random variables, defined by the truncation of the normal distribution with zero mean and variance $\sigma^2_u$.

## III. RESULTS AND DISCUSSION

The yield gap or the variability in crop production more especially in paddy has deleterious consequences in Bangladesh as well as in the world as a whole. The yield gap of paddy causes a great harm to meet the food requirement and to attain self-sufficiency of food grains in Bangladesh. It is very important to improve the level of understanding about the magnitude of variability in paddy production. Reduction of yield gap and improving technical efficiency is very much related to each other.

### Yield Gap Situation of MV Boro Paddy (BRRI Dhan 29) Production

In this study, yield gap is difference between on farm trial and the actual farm level yield was considered as the gap due to some technical and socioeconomic constraints. It is evident from Table 1 that the average per hectare yield of MV Boro paddy were as follows:

The results indicated that there was a yield gap between on-farm trial and farmers field of BRRI Dhan 29 for different farm sizes and also for credit receivers and non-receivers. If we consider the effect of credit remaining other things constant then it was observed that credit reduced 3.13 per cent of yield gap at both the villages. The credit receivers achieved 82.12 percent of on-farm trial yield while credit non-receiver achieved 78.99 percent at both villages. So, credit had positive impact on reducing yield gap between the on-farm trial and farmer's field. Large farmers of credit receiver group achieved the highest percentage of potential yield (84.50 per cent) followed by medium (82.68 per cent) and small farmers (80.27 per cent) of the same group. Potential yield is considered as on-farm trial yield. Large farmers

**Table 1. Per hectare yield gap of Boro paddy (BRRI Dhan 29) between the on-farm trial yields of BRRI and sample farmers**

| ame of the Villages | BRRI yield (Kg/ha) | Prod. of small farmers (Kg/ha) | Yield gap of small farmers (Kg/ha) | Prod. achieved as % of BRRI yield | Prod. of medium farmers (Kg/ha) | Yield gap of medium farmers (Kg/ha) | rod. achieved as % of BRRI yield | Prod. of large farmers (Kg/ha) | Yield gap of large farmers (Kg/ha) | Prod. achieved as % of BRRI yield | Average prod. of farmers (Kg/ha) | Average Yield gap of farmers (Kg/ha) | Average Prod. achieved as % of BRRI yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Neamatpur (CR) | 8500* | 6815.00 | 685.00 | 80.18 | 7045.00 | 456.00 | 82.88 | 7220.00 | 280.00 | 84.94 | 7002.00 | 1498.00 | 82.38 |
| Kamarchar (CR) | 8500* | 6830.00 | 670.00 | 80.35 | 7010.00 | 490.00 | 82.47 | 7145.00 | 355.00 | 84.06 | 6958.00 | 1542.00 | 81.86 |
| Credit Receiver | 8500* | 6822.50 | 1677.50 | 80.27 | 7027.50 | 1472.50 | 82.68 | 7182.50 | 1317.50 | 84.50 | 6980.00 | 1520.00 | 82.12 |
| Neamatpur (CNR) | 8500* | 6505.00 | 995.00 | 76.53 | 6885.00 | 615.00 | 81.00 | 7035.00 | 465.00 | 82.76 | 6743.00 | 1757.00 | 79.33 |
| Kamarchar (CNR) | 8500* | 6469.00 | 1031.00 | 76.11 | 6865.00 | 635.00 | 80.76 | 7025.00 | 465.00 | 82.65 | 6686.00 | 1814.00 | 78.66 |
| Credit Non Receiver | 8500* | 6487.00 | 2013.00 | 76.32 | 6875.00 | 1625.00 | 80.88 | 7030.00 | 1470.00 | 82.71 | 6714.50 | 1785.50 | 78.99 |

Source: Field Survey, 2001
*: BRRI. (2001)

of credit non-receiver group also achieved highest percentage of potential yield, which is 82.71 percentages while the medium and small farmers achieved 80.88 and 76.32 percent. So, there was a positive relationship between the potential yield achieved and farm size category.

## Effect of Different Factors on Yield Gap

The result of the estimated coefficient of the empirical model finding out the factors affecting yield gap of BRRI Dhan 29 is presented in the Table 2.

**Table 2. Effect of different factors on yield gap of BRRI Dhan 29**

| Different variables | Coefficients | t-ratio |
|---|---|---|
| Constant | 11.41* | 6.66 |
| Natural log of Human labor/ha (Man-Day) | 0.73** | 2.25 |
| Natural log of Mechanical power cost (Taka/ha) | -0.43$^{ns}$ | 1.50 |
| Natural log of Irrigation cost (Taka/ha) | -0.33** | 2.17 |
| Natural log of Urea (Kg/ha) | -1.25$^{ns}$ | 1.21 |
| Natural log of TSP (Kg/ha) | 1.51$^{ns}$ | 1.24 |
| Natural log of MP (Kg/ha) | -0.83$^{ns}$ | 1.23 |
| Credit receiver or non-receiver dummy | -0.23** | 2.36 |
| Natural log of Age | 0.03* | 3.14 |
| $R^2$ | 0.43 | |
| F | 6.59* | |

Note: * and ** stands for 1% and 5% level of significance

It is evident from the results presented in Table 2 that the coefficient of human labor cost/ha was positive and statistically significant in increasing yield gap of producing MV Boro paddy (BRRI Dhan 29). The coefficient implies that 1 per cent increase in human labor, remaining other factors constant, would result in an increase in yield gap by 0.73 per cent. This may happen due to over use of human labor especially family labor in producing MV boro paddy. So, human labor was an important factor influencing the yield gap of MV Boro paddy.

The coefficient of mechanical power cost was negative and statistically insignificant in explaining the yield gap of BRRI Dhan 29. This implies that 1 per cent increase in mechanical power cost, as additional expenditure, remaining other factors constant, would result in decrease in yield gap by 0.43 per cent and vise versa. Though the mechanical power did not play a significant role but this variable may reduce the yield gap of MV Boro paddy.

Table 2 shows that the estimated coefficient of irrigation cost was negative and statistically significant. It indicates that 1 per cent increase in irrigation cost, keeping other factors constant, would result in decrease in yield gap of BRRI Dhan 29 by 0.33 per cent. It seems that irrigation cost played an important role in reducing the yield gap of MV boro paddy.

The value of the coefficient of urea was negative and statistically insignificant which indicates that 1 per cent increase in the application of urea, keeping other factors constant, result in a decrease in yield gap by 1.25 per cent. The coefficient of MP was negative and statistically insignificant which indicates that 1 per cent increase in the application MP, keeping other inputs constant, result in a decrease in yield gap by 0.83 per cent. So, application of urea and MP may play a vital role in reducing the yield gap of the studied paddy though the coefficients are statistically insignificant.

TSP is one of the major fertilizers for MV Boro paddy production. It can be seen from Table 2 that the value of the coefficient of TSP was positive and statistically insignificant. It indicates that 1 per cent increase in the application of TSP, remaining other inputs constant, would result in an increase in yield gap by 1.51 per cent. This thing may happen due to over use of TSP in Boro paddy production.

The coefficient of credit dummy was significantly negative implies that the yield gap of the said paddy would be reduced by 0.23 percent if a farmer turned himself into credit receiver considering other factors constant. So, credit might play a significant role in reducing the yield gap of BRRI Dhan 29. So, government as well as financial institutions might think about the possibility of increasing the number of credit receiver so that higher yield potential of MV boro paddy can be obtained.

The coefficient of age was positive and statistically significant in measuring the yield gap of MV Boro paddy. This implies that 1 percent increase in age, remaining other factors constant, would result in a decrease in yield gap by 0.03 per cent. This result also implies that the yield gap would be reduced if the younger farmers are encouraged to be engaged in the cultivation process of the said paddy. It may be noted here that age was an important factor influencing the yield gap of MV Boro paddy.

The coefficient of multiple determination, $R^2$ was 0.43 for MV Boro paddy yield gap model. It is indicated that about 43 percent variation of yield gap of MV Boro paddy has been explained by the included explanatory variables of the model.

The estimated F-value of the equation derived for the model was 6.59. It is statistically highly significant implying that variation in yield gap of MV Boro paddy depends mainly upon the explanatory variables included in the model. Hence, F-value indicates that the specified model gave a reasonably good fit.

**Effect of Credit on Technical Efficiency**

This analysis had been done to observe the contribution of the effect of credit on technical efficiency on MV Boro paddy (BRRI Dhan 29) production in the Study area. The maximum likelihood estimates for the parameters of the Cobb-Douglas stochastic frontier production functions for the Boro paddy producers of the study area are given in table 3.

**Table 3. Maximum likelihood estimate of Stochastic Production Frontier and technical efficiency of MV Boro producers in the study area.**

| Variables | Parameter | Co-efficient | t-ratio |
|---|---|---|---|
| Constant | $\beta_1$ | 3.22* | 2.84 |
| In (Human labour) | $\beta_1$ | 0.67* | 2.57 |
| In (Mechanical power hrs.) | $\beta_1$ | -0.01 | 0.09 |
| In (Irrigation charge) | $\beta_1$ | 0.62* | 3.50 |
| In (Harvesting charge) | $\beta_1$ | -0.05 | 0.34 |
| In (Seed) | $\beta_1$ | 0.12 | 0.97 |
| In (Urea) | $\beta_1$ | -0.30 | 1.04 |
| In (TSP) | $\beta_1$ | 0.27 | 0.76 |
| In (MP) | $\beta_1$ | 0.25 | 1.33 |
| In (Land use cost) | $\beta_1$ | 0.85* | 6.18 |
| In (Interest on operating capital) | $\beta_1$ | -1.41* | 2.81 |
| $\sigma^2$ | | 0.009 | 6.04 |
| $\gamma$ | | 0.0000001 | 0.01 |
| Inefficiency | | | |
| Constant | $\delta_0$ | | |
| Tenant | $\delta_1$ | -0.23* | 6.28 |
| Farm size | $\delta_2$ | 0.01 | 0.11 |
| Age | $\delta_3$ | 0.01* | 2.96 |
| Education | $\delta_4$ | -0.001 | 0.04 |
| Extension contacted | $\delta_5$ | -0.01 | 0.57 |
| Credit receiver (CR) on non receiver (CNR) | $\delta_6$ | -0.04 | 1.20 |
| Likelihood ratio test | | | 35.26* |

Note: * indicates significant at 1% level.

The elasticities of all variable inputs except interest on operating capital were inelastic indicating that the Boro producers in the study area were not so much sensitive to changes in input prices of paddy production. The returns to scale was 1.01 indicating that the farmers operated in a constant returns to scale with all inputs in aggregate. The elasticity figures of mechanical power, harvesting cost, urea used, and interest on operating capital were negative, which indicate that the output of Boro decreases with the additional use of those inputs.

## Technical Efficiency of the CR and CNR Group of Farmers in the Study Area

Technical efficiency of the selected farmers of Credit Receivers (CR) and Credit Non Receivers (CNR) with different factors are described below:

**Table 4. Technical efficiency of credit receivers (CR) and credit non-receivers (CNR) of Boro paddy production according to tenure status**

| Tenure status | Credit receiver / credit non receiver | | | | Group Total | |
|---|---|---|---|---|---|---|
| | Credit receiver | | Credit non receiver | | Mean | Standard Error of Mean |
| | Mean | Standard Error of Mean | Mean | Standard Error of Mean | | |
| Owner-cum-tenant | 0.66* | 0.01 | 0.61* | 0.01 | 0.63* | 0.01 |
| Owner operator | 0.81* | 0.02 | 0.74* | 0:02 | 0.77* | 0.01 |
| Group Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |

Note: * indicates significant at 1% level.

Table 4 indicated that the level of technical efficiency was 81 and 74 percent for the owner operator of both CR and CNR categories while it was 66 and 61 percent for both the group of owner-cum-tenant. In this analysis it is seen that the owner-cum-tenant and owner operator farmers of CR category were technically more efficient than that of CNR category. The estimated co-efficient for the tenure status of the farmers in the inefficiency model was significantly negative indicating that the owner operators of both CR and CNR categories tended to be technically more efficient than the owner-cum-tenant farmers. The entire mean coefficients were statistically significant at 1% level because half of the mean co-efficient were greater than respective standard error of mean.

**Table 5. Technical efficiency of credit receivers and credit non-receivers of Boro paddy production according to age distribution**

| Age category | Credit receiver / credit non receiver | | | | Group Total | |
|---|---|---|---|---|---|---|
| | Credit receiver | | Credit non receiver | | Mean | Standard Error of Mean |
| | Mean | Standard Error of Mean | Mean | Standard Error of Mean | | |
| Age below 40 | 0.79* | 0.04 | 0.76* | 0.06 | 0.78* | 0.03 |
| 40 to 50 | 0.72* | 0.02 | 0.68* | 0.02 | 0.70* | 0.01 |
| 40 to 50 | 0.72* | 0.02 | 0.68* | 0.02 | 0.70* | 0.01 |
| 51 and above | 0.68* | 0.03 | 0.62* | 0.02 | 0.63* | 0.02 |
| 51 and above | 0.68* | 0.03 | 0.62* | 0.02 | 0.63* | 0.02 |
| Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |
| Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |

Note: * indicates significant at 1% level.

The technical efficiency was highest (79 percent for the CR and 78 percent for the CNR) for the below 40 years age category and lowest (68 percent for CR and 63 percent for CNR) for the 51 and above age category. From this point, one may argue that the CR farmers of all categories were technically more efficient than the CNR farmers of all age categories. On the other hand, it is seen that overall technical efficiency indicators were 78, 70 and 63 per cent for the age level of (below 40), (40-50) and (51 and above) category respectively. So, it can be said that the rate of technical efficiency tended to decrease corresponding to the increase of age measured in years. The positive and highly significant co-efficient for the age variable in the inefficiency model implies that the older farmers are more technically inefficient than the younger farmers. This could be explained in terms of the adoption of modern technology. Younger farmers tend to be more progressive and receptive to modern and newly introduced agricultural technology. The same result was also obtained by Ajibefun *et al.* (1996).

**Table 6. Technical efficiency of credit receivers and credit non-receivers of Boro paddy production according to educational level**

| Educational Status | Credit receiver / credit non receiver | | | | Group Total | |
|---|---|---|---|---|---|---|
| | Credit receiver | | Credit non receiver | | | |
| | Mean | Standard Error of Mean | Mean | Standard Error of Mean | Mean | Standard Error of Mean |
| Illiterate | - | - | 0.65* | 0.04 | 0.65* | 0.04 |
| Primary | 0.64* | 0.06 | - | - | 0.64* | 0.06 |
| Primary | 0.64* | 0.06 | - | - | 0.64* | 0.06 |
| Up to Secondary | 0.71* | 0.02 | 0.64* | 0.02 | 0.67* | 0.01 |
| Up to Secondary | 0.71* | 0.02 | 0.64* | 0.02 | 0.67* | 0.01 |
| Secondary | 0.74* | 0.02 | 0.62* | 0.04 | 0.71* | 0.02 |
| Secondary | 0.74* | 0.02 | 0.62* | 0.04 | 0.71* | 0.02 |
| Higher secondary | 0.95* | 0.03 | 0.69* | 0.04 | 0.75* | 0.07 |
| Higher secondary | 0.95* | 0.03 | 0.69* | 0.04 | 0.75* | 0.07 |
| Graduate | 0.92* | 0.05 | 0.72* | 0.03 | 0.76* | 0.04 |
| Graduate | 0.92* | 0.05 | 0.72* | 0.03 | 0.76* | 0.04 |
| Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |
| Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |

Note: * indicates significant at 1% level.

There was a positive relationship between the educational level and technical efficiency of CR and CNR category of farmers. Technical efficiency was 65 per cent for the illiterate farmers while it was 76 per cent for the graduate farmers at aggregate level (Table 6). Among the CR group the highest technical efficiency was observed for higher secondary passed farmers and the lowest for primary passed farmers. A similar trend was observed for CNR group of farmers. The negative coefficient for education in the inefficiency model implies that the farmers with more education tend to be less efficient. Thus may happen because the farmers with more education respond more readily in using the improved technology and produce more output with similar amount of inputs.

**Table 7. Technical efficiency of credit receivers and credit non-receivers of Boro paddy production according to frequency of extension contacted**

| Frequency of extension contacted | Credit receiver / credit non receiver | | | | Group Total | |
|---|---|---|---|---|---|---|
| | Credit receiver | | Credit non receiver | | | |
| | Mean | Standard Error of Mean | Mean | Standard Error of Mean | Mean | Standard Error of Mean |
| Below 4 | 0.66* | 0.04 | 0.61* | 0.02 | 0.63* | 0.02 |
| 5 to 6 | 0.70* | 0.02 | 0.67* | 0.02 | 0.68* | 0.02 |
| 5 to 6 | 0.70* | 0.02 | 0.67* | 0.02 | 0.68* | 0.02 |
| 7 to 8 | 0.71* | 0.02 | 0.64* | 0.02 | 0.69* | 0.02 |
| 7 to 8 | 0.71* | 0.02 | 0.64* | 0.02 | 0.69* | 0.02 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 to 10 | 0.82* | 0.02 | 0.67* | 0.03 | 0.73* | 0.03 |
| 11 to 12 | 0.93* | 0.03 | 0.82* | 0.04 | 0.87* | 0.03 |
| 11 to 12 | 0.93* | 0.03 | 0.82* | 0.04 | 0.87* | 0.03 |
| Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |
| Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |

Note: * indicates significant at 1% level.

Table 7 showed the positive impact of frequency of extension contact on the technical efficiency of Boro producers in the study area. It is observed that the CR farmers were technically more efficient given than the CNR farmers to the every single frequency of extension contact. The technical efficiency was highest for the farmers with higher frequency of extension contacted for both the CR and CNR farmers. But the technical efficiency was higher for CR farmers than that of the CNR farmers. The parameter of the variable extension contacted in the inefficiency model was negative and insignificant for the Boro producers. This result showed that the involvement of the extension advisors tend to reduce the technical inefficiency of Boro paddy production. The entire mean coefficients were statistically significant at 1% level because half of the mean co-efficient were greater than respective standard error of mean.

**Table 8. Technical efficiency of credit receivers and credit non-receivers of Boro paddy production according to location**

| Village | Credit receiver / credit non receiver | | | | Group Total | |
|---|---|---|---|---|---|---|
| | Credit receiver | | Credit non receiver | | Mean | Standard Error of Mean |
| | Mean | Standard Error of Mean | Mean | Standard Error of Mean | | |
| Neamatpur | 0.72* | 0.02 | 0.67* | 0.02 | 0.69* | 0.01 |
| Kamarchar | 0.74* | 0.02 | 0.66* | 0.02 | 0.70* | 0.02 |
| Total | 0.73* | 0.02 | 0.66* | 0.01 | 0.70* | 0.01 |

Note: * indicates significant at 1% level.

The technical efficiency was seen 72 and 67 per cent for the CR and CNR farmers of Neamatpur village, while it accounted for 74 and 66 per cent for the CR and CNR farmers of Kamarchar village. Table 8 indicated that the CR farmers were comparatively more technically efficient than the CNR farmers at both the villages. The overall technical efficiency of Neamatpur and Kamarchar was 69 and 70 per cent (Table 8) respectively, which means the technical efficiency of Kamarchar was slightly higher than that of Neamatpur village.

Highest percentage (45%) of farmers stands at the range of 61 to 70 per cent of technical efficiency (Table 9) of both the categories of farmers. Only 5 per cent of the CR group of farmers stands at the range of below 60 per cent and above 91 per cent level. Of the CNR group 27.5 percent stands below 60 per cent category while no farmer was above 91 per cent category. So, positive impact of credit was observed for technical efficiency of Boro producers in the agro-ecological region.

**Table 9. Frequency of technical efficiency**

| Range of technical efficiency (percentage) | Credit receiver / credit non receiver | | | | Group Total | |
|---|---|---|---|---|---|---|
| | Credit receiver | | Credit non receiver | | Count | Percentage |
| | Count | Percentage | Count | Percentage | | |
| below 60 | 2 | 5.0 | 11 | 27.5 | 13 | 16.3 |
| 61 to 70 | 18 | 45.0 | 18 | 45.0 | 36 | 45.0 |
| 71 to 80 | 9 | 22.5 | 8 | 20.0 | 17 | 21.3 |
| 81 to 90 | 9 | 22.5 | 3 | 7.5 | 12 | 15.0 |
| 91 and above | 2 | 5.0 | - | - | 2 | 2.5 |
| Total | 40 | 100.0 | 40 | 100.0 | 80 | 100.0 |

## IV. CONCLUSIONS

The present study was undertaken to estimate the impact of credit on yield gap and technical efficiency of boro paddy producers (BRRI Dhan 29) a selected area of Comilla district. The tabular presentation showed that credit receivers achieved 82.12 percent and credit non-receiver achieved 78.99 percent of the on-farm trial yield conducted by the Bangladesh Paddy Research Institute (BRRI). So, there is a wide gap of 18 to 21 percent between the farmer's field yield and on-farm trial yield. It was also showed that the gap was higher for the credit non-receivers than for the credit receivers. So, it could be said that credit has positive impact on reducing yield gap. The study also identified the factors influencing yield gap through a double log multiple regression analysis. Mechanical power cost, irrigation cost, application of urea, application of MP and credit dummy had positive impact on reducing yield gap while human labor, TSP application and age had negative impact on reducing yield gap. So, farmers have to increase the use of mechanical power, irrigation water, urea, MP and credit money while they need to decrease the use of human labor and TSP for reducing yield gap. Credit also showed positive impact on increasing technical efficiency. The estimated frontier production function was statistically significant. Technical efficiency was higher for credit receivers than for the non-receivers according to tenure status, age category, educational status, and frequency of extension contacted. Owner operators, younger farmers, literate persons and extension-contacted persons were technically more efficient than the owner-cum tenant, older, less educated and less extension contacted farmers.

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