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RESEARCH ARTICLE

Effects of partial quantity rationing of credit on technical efficiency of Boro rice growers in Bangladesh: Application of the stochastic frontier model

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ABSTRACT

In this study, we analyzed the effects of the partial quantity rationing of credit on the technical efficiency of Boro rice growers in the Pabna district of Bangladesh. Before conducting the field survey, we designed a theoretical framework and identified farm households affected by the partial quantity rationing of credit. Data were collected from 174 Boro rice growers and analyzed in two stages, where the technical efficiency of Boro rice growers was assessed using stochastic frontier analysis, and the inefficiency effects model was then applied to evaluate determinants of the technical efficiency. The mean technical efficiency of Boro rice growers was 78%, which indicates that their technical efficiency was 22% beyond the production frontier curve. The variables comprising the household head's age, education level, seed quality, formal training, access to the market, farm labor, tillage cost, fertilizer cost, irrigation cost, and price of seedlings significantly affected the technical efficiency of rice growers. The variables of interest comprising the rate and partial quantity rationing of credit had significant negative effects on the technical efficiency of rice growers. The findings obtained in this study will help to enhance the actual production level using the available resources and improve the food security situation in Bangladesh.

Keywords: Bangladesh; Credit constraints; Stochastic frontier analysis; Technical efficiency

INTRODUCTION

The rice industry is considered to be the backbone of the national economy in Bangladesh, which is the fourth largest producer and the third largest consumer of rice throughout the world (Roy et al., 2014; Shew et al., 2019). Rice cultivation provides employment to 48% of the country's labor force and contributes 70% to the national agricultural gross domestic product. Moreover, rice growers account for one-sixth of the national income in Bangladesh (FAO 2018). The three main rice varieties grown in Bangladesh are Aus, Amon, and Boro. Rice is cultivated on 74.85% of the total cultivable area in Bangladesh, where Aus is grown on 8.94% of the area, Amon on 49.12%, and Boro on 41.91% (BBS 2018). The estimated total food grain production in FY 2018–19 was 41.57 million tonnes in Bangladesh and rice accounted for 36.46 million tonnes (BBS 2019).

However, the average rice production per hectare in Bangladesh is much lower than those in other Asian countries, such as Japan, Indonesia, Vietnam, China, and South Korea (Jalilov and Mainuddin 2019). Average rice production is 5.63 tonnes/ha in Vietnam, 3.0 tonnes/ha in Thailand, and 3.59 tonnes/ha in India, but only 2.93 tonnes/ha in Bangladesh (FAOSTAT, 2014). During 2019, the total area cultivated with Boro rice in Bangladesh was 56,317 ha and the total production was 225,208 tonnes

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(BBS 2019). This low productivity compared with other global players is an enormous economic disadvantage. In order for subsistence rice growers to advance their technical efficiency, it is necessary to identify the key factors that affect rice production, thereby determining the best system to allow the implementation of new production techniques that reduce costs and optimize the utilization of resources (Charnes et al., 1978; Fatemi and Atefatdoost, 2020; Kumar et al., 2020; Li et al., 2020). Thus, studying the technical efficiency of rice growers can allow us to optimize the allocation of inputs by farms. Indeed, obtaining this information can facilitate the development of a policy tool to improve the efficiency of rice farming in Bangladesh.

Natural factors and the climate of Bangladesh make it highly suitable for rice cultivation but rice growers are affected by several challenges, such as a lack of advanced production techniques and effective technology, poor quality seed, high costs of fertilizer and pesticides, and the low availability of water for irrigation purposes. These issues are linked to the financial constraints on farmers. Previous studies have indicated that credit constraints on farmers are important factors that affect farm productivity (Bashir et al. 2010; Bashir and Mehmood 2010; Gautam and Ahmed, 2019; Jin et al., 2019; Komicha and Öhlmer, 2008; Mehmood et al., 2018). Constraints on credit can have explicit and implicit impacts on the rice production process, where they may explicitly affect the ability of producers to pay their running costs, and they can influence the perceived risk among farmers regarding the adoption of advanced technology (Carrer et al., 2020; Diana et al., 2010; Boucher et al., 2008; Duong and Thanh, 2019; Kattel et al., 2020; Shew et al., 2019). Thus, farmers who are credit-constrained and with insufficient savings will avoid taking risks, and they are reluctant to invest in modern farm technology. This risk avoidance attitude limits the capacity of growers to reach actual production benchmark levels (Mehmood et al. 2021).

Similar to farmers in other emerging countries, most of the farmers in rural Bangladesh are trapped in a vicious circle of poverty and debt, where they require credit to purchase farm inputs and increase productivity (Bidisha et al., 2018; Long, Thap, and Hoai 2020; Mehmood et al. 2021). In addition, rural financial institutes have little interest in disbursing loans to the agrarian sector due to the perceived risky nature of the business, difficulties with loan recovery, and other exogenous factors (Mehmood et al., 2017; Li et al., 2016; Arshad et al., 2017). The partial disbursement of loans to farmers by financial institutions leads to credit constraints and reduced farm yields.

In the present study, we conducted the first investigation of the impact of partial credit rationing on the technical efficiency of Boro rice growers in Bangladesh. In China, a similar study by Zhao and Barry (2014) examined the impacts of supply-side and demand-side credit constraints on the technical efficiency of rural households. However, in the present study, we aimed to extend the literature regarding technical efficiency by analyzing issues that were not considered in previous investigation. First, we analyzed the influence of partial credit rationing on the technical efficiency of Boro rice growers in Bangladesh. Second, the determinants of the technical efficiency of Boro rice growers were estimated by considering the diversified income sources of farmers. Analyzing the effects of credit constraints on the technical efficiency of Boro rice growers is crucial for developing appropriate agricultural policies and removing the financial constraints on farmers. The hypothesis tested in this study is defined as follows.

H0: Partial quantity rationing of credit has no effect on the technical efficiency of rice growers.

H1: Partial quantity rationing of credit affects the technical efficiency of rice growers.

The remainder of this study is organized as follows. The theoretical framework employed to identify the partial quantity rationing of credit is explained in Section 2. The survey design, data collection procedure, variable selection process, and empirical model are described in Section 3. In Section 4, we present the findings obtained by maximum likelihood estimation of the production frontier and using the inefficiency effects model. Our main findings and recommendations are provided in the Conclusion section.

Theoretical model and identification of partial quantity rationing of credit

The theoretical framework was designed before conducting the field survey in order to identify the partial quantity rationing of credit (Figure 1), which generally occurs when financial institutes allocate inadequate funds to debtors. In particular, we aimed to identify the partial quantity rationing of credit, so we excluded other types of credit constraints from the empirical analysis. When total quantity rationing arises, financial institutions refuse loan applications based on the previous loan history of applicants, lack of guarantors, inadequate collateral, and other factors. It has been shown that control supervision and asymmetric information can create both partial and total credit rationing situations (Mehmood et al., 2018). Conversely, farmers are considered credit non-constrained when they fulfill the necessary criteria for loans and receive them from financial institutions.

MATERIALS AND METHODS

Stochastic production frontier and inefficiency effects models

We used the stochastic frontier model (a parametric approach) proposed by Aigner et al. (1977) to analyze the technical efficiency of Boro rice growers in Bangladesh because this method is considered the most appropriate for agricultural studies (Tenaye 2020). Furthermore, this method is considered reliable for conventional hypothesis testing, where it can examine stochastic data errors and evaluate inefficiency effects in single steps (Kumbhakar and Lovell 2000). The model is defined as:

y_i=f(x_i;β) exp(ε_ij), (1)

where the output of the i^{th} Boro rice grower is represented y_i by, the vector of diverse input variables is denoted by X_i, β is defined as a vector of unidentified technological parameters, and ε is the error term. The total error subscripts i and j are used for the i^{th} farm selected as the sample and the application of inputs, respectively. The error term has two separate components in this equation, i.e., $\varepsilon_i = \nu_i - \mu_i$. In particular ν_i, denotes the first error factor that explains the stochastic error and related risks associated within the frontier. The error component is assumed to be distributed independently and identically as $N(0,\sigma_v^2)$. In addition, μ_i represents the second error factor known as a non-negative random variable, where it measures the technical inefficiency of the samples and it follows a half-normal distribution.

The proportion of the projected output (y) relative to the highest feasible output (y*) by rice farmers is an indicator of the technical efficiency (TE_i), and it is defined as follows.

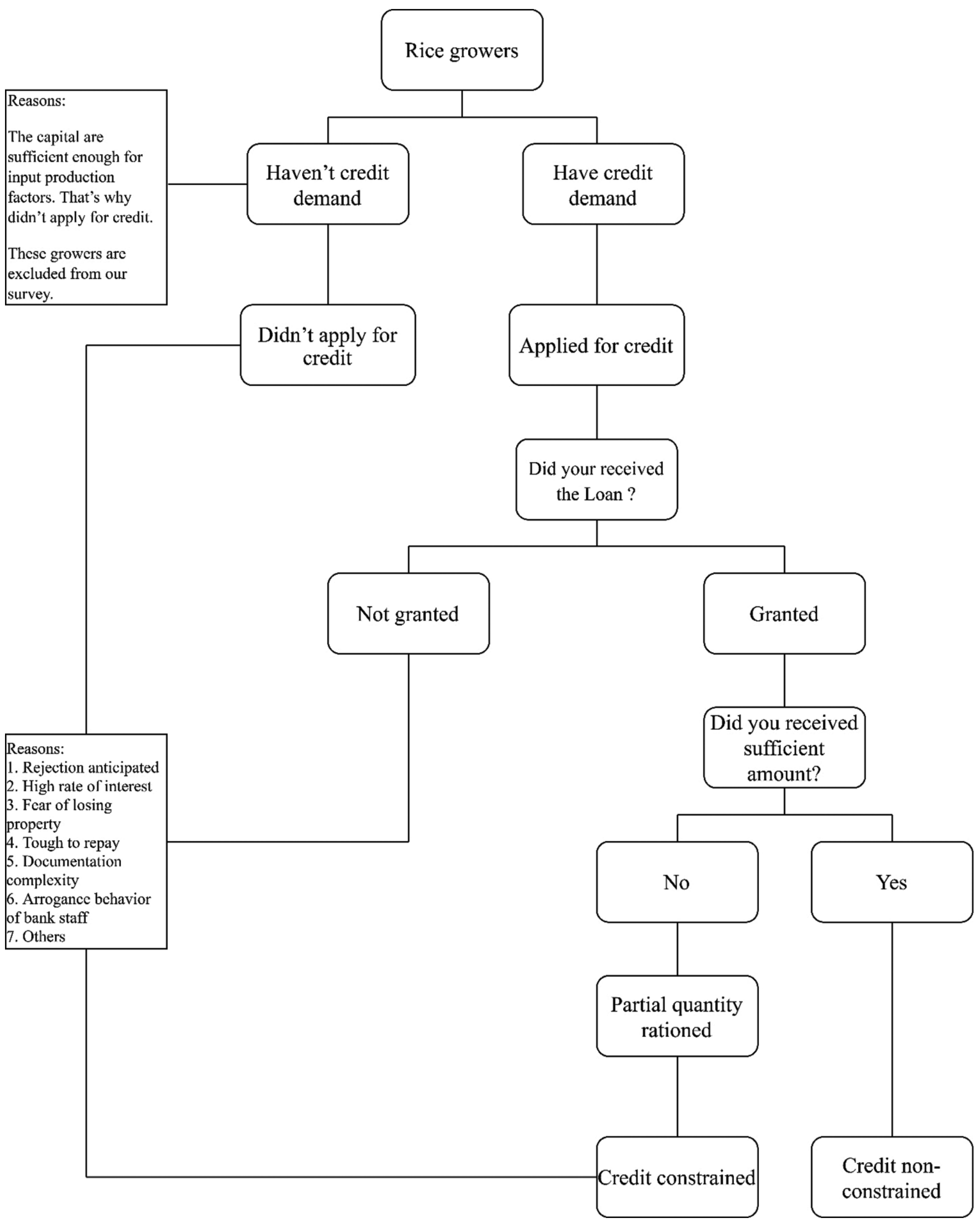

Fig 1. Theoretical model for identification of partial quantity rationed Boro rice growers

$$TE_i = \frac{f\left(x_{ij};\ \beta\right).\exp(u_i - \mu_i)}{f\left(x_{ij};\ \beta\right).\exp(u_i)} \exp\{-(\frac{\mu_i}{\varepsilon_i})\} \tag{2}$$

$$TI_i = 1 - TE_i$$

Technical efficiency scores ($y \leq y^*$) vary from 0 to 1. Using the quantities of all inputs, rice farmers can obtain a maximum score of 1. In addition, the technical efficiency of households should be measured using ε_i (Jondrow et al. 1982). The value predicted for μ_i subject to ε_i is defined as follows.

$$E\ (u_i \mid \varepsilon_i) \frac{\sigma_u \sigma_v}{\sigma} [\frac{f(\frac{\varepsilon_i \lambda}{\sigma})}{1 - F(\frac{\varepsilon_i \lambda}{\sigma})} - \frac{\varepsilon_i \lambda}{\sigma}] \tag{3}$$

The variance parameter in stochastic frontier analysis (SFA) is: $\sigma^2 = \sigma_u^2 + \sigma_\mu^2; \lambda = \frac{\sigma_u}{\sigma}$, where f(·) and F(·) are single and cumulative standard normal density functions, respectively. The variance parameter estimators are evaluated using the maximum likelihood method, i.e., σ_u^2 and σ_μ^2. Therefore, the technical efficiency approximation for each respondent is equal to the following.

$$TE_i = \exp\ (-E[u_i \mid \varepsilon_i]) \tag{4}$$

Model specifications

The log-linear structure of the SFA framework was used to approximate the technical performance of Boro rice farmers as follows.

$$\text{In } Y_i = \beta_0 + \sum_{j=i}^{8} \beta_{ij}\ \text{In } x_{ij} + v_i - \mu_i \tag{5}$$

The model proposed by Aigner et al. (1977) was extended by Caudill, Ford, and Gropper (1995), where inefficiency effects were introduced to quantify the magnitudes of the specific variables related to a firm's inefficiency, which can be measured by applying a multiplicative heteroscedasticity method:

$$\sigma_{\mu i} = \sigma_\mu exp\left(Z_{mi}; \alpha\right) \tag{6}$$

where Z_{mi} represents the technical and managerial practices of Boro rice growers that explain their inefficiency, and α is a parameter denoting the predicted impact of inefficiency. In addition, the model hypothetically follows a half-normal distribution for inefficiency, and thus decreases in the variance values will increase the efficiency of rice farmers. Finally, the general inefficiency model used to assess the inefficiency factors for rice growers specifically with respect to the partial quantity rationing of credit (i.e., supply-side rationing) is expressed as follows.

$$IE\_i = \alpha + \delta_1\ SR_1 + \beta_x + \eta_i \tag{7}$$

$$\begin{cases} 0 \ \ if \quad IE_i \leq 0 \\ IE_i \ if \quad 0 < IE_I < 1 \\ 1 \ \ if \quad IE_i \geq 0 \end{cases} \tag{8}$$

Survey design

The survey was conducted in 2018 and primary data were collected in Pabna district, Bangladesh. A random sampling technique was applied and 10 unions were selected in Pabna district. Information regarding details such as rice production, input costs, the use of advanced farm machinery, production and harvesting methods, the outputs produced, financial status of farmers, loan amounts requested, and loan amounts approved were recorded using a well-structured questionnaire. In total, 174 respondents were recruited and the theoretical framework was used to identify 48 respondents affected by the partial quantity rationing of credit, whereas 126 respondents were identified as not affected by credit rationing. In the survey area, 33.33% of the Boro rice growers generated income from diverse sources, including other crop farming, dairy farming, fishing, and poultry, and crop farming was a substantial secondary source of income for these farmers. The remaining 66.67% of Boro rice growers generated their primary income from rice farming and it was treated as their primary income source. The results indicated that 27.59% of the interviewees reported experiencing partial credit rationing, whereas 72.41% reported no credit rationing from financial institutions. Table 1 lists the sources of income and status of the credit limits for the respondents.

Data

The empirical study was based on the approximation of Cobb–Douglas production function. The input and output variables were analyzed in logarithmic form. Finally, we rejected the Translog functional framework for tentative comparisons.

In the first stage of our analysis (see Table 2), the dependent variable was considered for one cropping season and the

Table 1: Income sources, and credit-constrained and non-constrained status of the respondents

(i) Income sources	Total	Percentage
Rice farming as a primary/main income source (Herfindahl–Hirschman percentage)	116	66.67
Diverse sources of income including crop farming (Herfindahl–Hirschman percentage)	58	33.33
Total	174	100
(ii) Credit constrained and non-constrained status		
Partial quantity rationed	48	27.59
Credit not rationed	126	72.41
Total observations	174	100

total rice yield was estimated on a kilogram and per acre basis. The seven independent variables considered in this study comprised the labor cost, cost of seedlings, tillage cost, fertilizer cost, pesticide cost, irrigation cost, and land rent. The farm labor cost) represents the total labor cost paid for a cropping season measured as the per day per labor wage (in BDT). The cost of seedlings X_2 represents the total cost paid for seedlings per 100 bundles on a per acre basis. The tillage cost X_3 represents the cost spent plowing fields on a per acre basis. The cost of fertilizer application X_4) represents the total cost paid for fertilizer applied as urea and potash in kilograms on a per acre basis. The cost of pesticides (X_5) represents the total cost of pesticides sprayed in the field in kilograms on a per acre basis. The irrigation cost (X_6) represents the total cost of irrigation in terms of electricity and fuel to provide water (on a per acre basis in a cropping season). The land rent X_7 represents the total land rent paid for cultivating rice crops per acre.

The inefficiency effects model was used in the second phase to estimate the determinants of the technical efficiency of farmers. The independent variables in this study comprised the age of the household head representing farming experience (years), the household head's education level measured in terms of years of formal schooling, family size representing the total number of family members in the household, farm size measured in acres, seed quality as a dummy variable representing certified seed usage (if certified seed used, then 1; otherwise, 0), training as a dummy variable representing training received (if training received, then 1; otherwise, 0), and access to market representing the availability of the market (if the market is convenient, then 1; otherwise, 0). Income diversification was used as an index of income differentiation among respondents. The main standard measure among different indices used in previous studies is the estimated income diversification. We used the Herfindahl–Hirschman (HH) index ($\sum_{i=1}^{n} S_i^2$) . Finally, we included two variables in the analysis comprising the interest rate charges on the principal amount determined by the borrowing costs (percent, %), and the partial quantity rationing of credit as a dummy variable (yes = 1, otherwise = 0).

Table 2: Summary statistics for variables used in stochastic frontier analysis and the inefficiency effects model

Variables	Mean	SD	Min.	Max.
Output per acre kg	1279	576.04	400	5000
Farm labor cost per day per labor wage (BDT)	454	27	365	575
Cost of seedlings per 100 bundles (BDT)	202.83	6.32	200	220
Tillage cost per acre (BDT)	1364	1079.60	192	7350
Cost of fertilizer per kg (BDT)	34	1.37	29.59	41.38
Cost of pesticides per kg (BDT)	187	58.09	120	250
Irrigation cost per acre (BDT)	3148	1325.14	1050	11360
Land rent per acre (BDT)	3652	1892.38	2700	18000
Total cost of production (BDT/acre)	23027	10666	7083	83108
Summary statistics: Explanatory variables	**Mean**	**SD**	**Min.**	**Max**
Age of household head (years)	42.92	11.17	18.00	65.00
Education level (years of schooling)	4.72	3.71	0.00	17.00
Family size (number)	5.38	1.42	2.00	11.00
Farm size (acres)	0.58	0.24	0.12	4.50
Seed quality (certified = 1, otherwise = 0)	0.87	0.49	0.00	1.00
Training (yes = 1, no = 0)	0.76	0.42	0.00	1.00
Access to market (market convenient = 1, otherwise = 0)	0.81	0.34	0.00	1.00
Income diversification (Herfindahl–Hirschman index)	0.187	0.254	0	0.8
Interest rates based on principal amount (%)	10.25	4.25	9	12
Partial quantity rationed (yes = 1; otherwise = 0)	0.364	0.521	0	1

1 US$ = 84 BDT

RESULTS AND DISCUSSION

Maximum likelihood estimates of the production frontier

The maximum likelihood estimates are presented in Table 3. All of the coefficient values obtained for the selected variables were statistically positive and significant, except for the cost of pesticides. Furthermore, the irrigation cost had the highest effect among all of the input variables, with an estimated elasticity of 0.83, thereby indicating that an increase of 1% in the irrigation cost would increase the rice productivity by 0.83%. The next highest elasticity values were obtained for the farm labor cost (0.65), followed by the average cost of fertilizer (0.49), cost of seedlings (0.31), tillage cost (0.15), cost of pesticides (–0.23), and land rent (0.10).

According to our analysis, the calculated scale elasticity was 2.04, thereby indicating an increasing return to scale.

Table 3: Stochastic frontier analysis of farm households

Input variables	Coefficient	SE
Intercept	–13.10***	2.26
Farm labor cost per day per labor wage (BDT)	0.65**	0.25
Cost of seedlings per 100 bundles (BDT)	0.31**	0.14
Tillage cost per acre (BDT)	0.15	0.24
Cost of fertilizer per kg (BDT)	0.49**	0.23
Cost of pesticides per kg (BDT)	–0.23	0.88
Irrigation cost per acre (BDT)	0.83**	0.30
Land rent per acre (BDT)	0.10	0.15

Log likelihood function = 67, Wald χ^2 = 1,329, $\lambda = \sigma_\mu/\sigma_\upsilon$ = 3.72, σ^2 = 0.086
*p < 0.10; ** p < 0.05; *** p < 0.01
1 US$ = 84 BDT

Therefore, the calculated scale effect was larger than 1, and thus a 1% increase in the total production costs would increase the total Boro rice production by 2.04%. In general, the increasing return to scale for Boro rice growers in the Pabna district suggests that there was a strong relationship between the input and output levels. Furthermore, the increasing return to scale also indicates that increasing the input level would lead to a proportionate or greater intensification of the output and a decrease in the average production cost. Thus, we found that the return to scale could be increased for the average Boro rice grower in the study area.

Factors that affected the technical efficiency of Boro rice farmers

We determined the effects of the estimated parameters on the technical efficiency. Equation (2) was employed to assess adverse impacts on the technical inefficiency and positive influences on the technical efficiency. Cabrera, Solís, and del Corral (2010), and Mehmood et al. (2017, 2018) also used the inefficiency effects model to evaluate and interpret impacts using a similar approach.

Clearly, the technical efficiency was relatively greater when the household head had a higher educational level (Table 4). Education regarding agricultural activities will enhance the management capability. In addition, implementing modern technology and convenient access to credit will have positive effects on the technical efficiency of farmers. We found that the coefficient was significantly negative for education and it had a positive impact on the technical efficiency. Another significant indicator according to Table 4 was income diversification, thereby demonstrating that a suitable combination of diverse income sources could improve the technical efficiency.

In rural Bangladesh, diversified income sources often help to overcome poverty because they can increase the productivity of farm households and stabilize incomes. The coefficient for training showed that it had a substantial positive impact on the technical efficiency of rice growers, possibly because the farmers with access to appropriate training facilities were technically more productive in the study area in Pabna. The seed quality had a significant impact on the technical efficiency of rice growers at the 5% level. Most of the farmers used high-quality seed for rice cultivation.

Table 4: Effects of various factors on the technical efficiency of Boro rice farmers

Input variable	Coefficient	SE
Constant	2.32	0.18
Age of household head (years)	–0.03	0.05
Education level (years of schooling)	–0.08**	0.04
Family size (number)	0.06	0.04
Farm size (acres)	–0.07	0.08
Seed quality (certified = 1, otherwise = 0)	–0.07**	0.03
Training (yes = 1, no = 0)	–0.08***	0.03
Access to market (market convenient = 1, otherwise = 0)	–0.17	0.08
Income diversification (Herfindahl–Hirschman index)	–1.121**	0.401
Interest rates (percentage)	0.241	0.141
Partial quantity rationed (yes = 1; otherwise = 0)	0.641**	0.351

*$p < 0.10$; ** $p < 0.05$; *** $p < 0.01$
1 US$ = 84 BDT

The coefficient value for interest rates indicates that increases in interest rates could adversely affect the technical efficiency of rice growers. Indeed, interest rates can have two distinct effects on farm production by influencing the inventory costs, and affecting the risk and financial investments by farmers in the procurement of advanced equipment, farm inputs, and land. These findings are similar to those obtained in Pakistan by Mehmood et al. (2017), but different from those found in Ethiopia by Komicha and Ohlmer (2008) who showed that the impact of interest rates on the technical efficiency was negligible. Finally, the critical variable indicates that the partial quantity rationing of credit adversely affected the technical efficiency of rice farmers. On average, partial quantity credit rationing significantly reduced the technical efficiency by 0.64 units, probably because the partial credit constraint imposed by financial intuitions discouraged farmers from investing in the optimum level of inputs, thereby decreasing their technical efficiency. The ranges of the technical efficiency values are presented in Table 5. The mean technical efficiency was 78% and the standard deviation was 0.38. Thus, the amount of rice produced by the average rice grower in the Pabna district of Bangladesh could be increased by 22% by utilizing their current resources more effectively.

Furthermore, 87% of the Boro rice growers (see Table 5) in the study area had technical efficiency scores of 80%. The technical efficiency scores estimated for rice growers in China by Min, Paudel, and Feng-bo (2020), and by Wang, Etienne, and Ma (2020) were 74% and 89%, respectively, and the mean technical efficiency score estimated in the present study was 78%. Our findings are also similar to

Table 5: Distribution of technical efficiency scores

Range	Frequency	Technical efficiency scores (%)
40–59	4	0.02
50–59	5	0.03
60–79	14	0.08
80–89	23	0.13
90–100	128	0.74
Mean technical efficiency	0.78	78
Standard deviation of technical efficiency	0.38	-

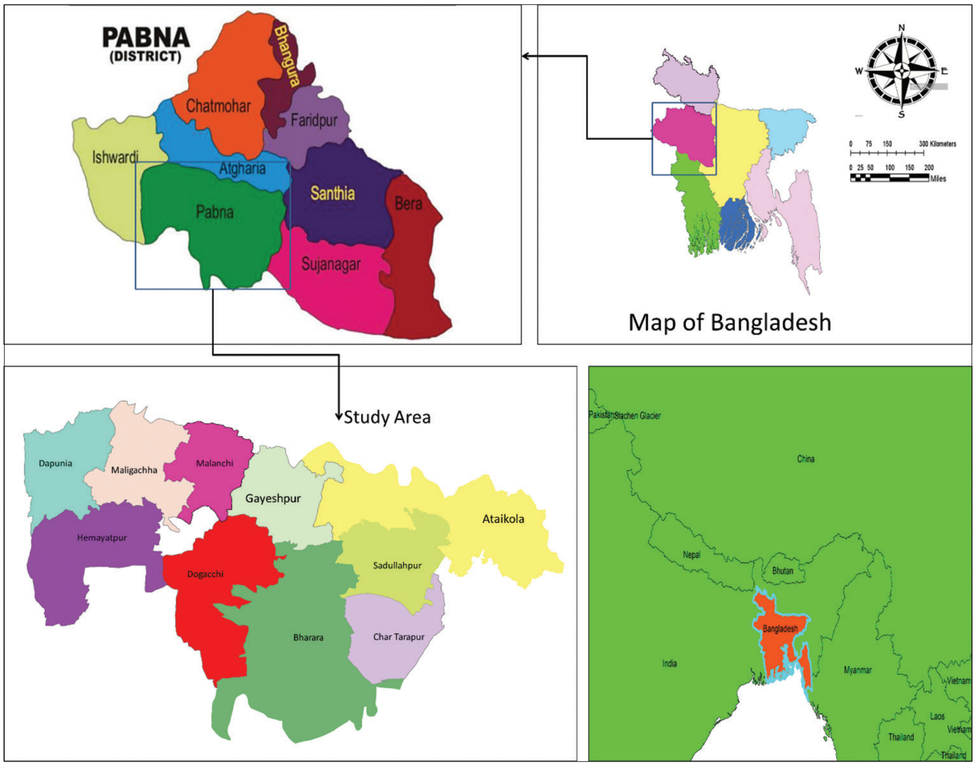

Fig 2. Study area in Pabna district, Bangladesh

those obtained previously in Bangladesh (Balcombe et al. 2007; Jalilov et al. 2019). The technical efficiency in south Asia was determined as 92% with a range from 82% to 97% by Bibi et al. (2020). Therefore, rice producers in Bangladesh could possibly compete better in the global rice market if more effort is made to enhance research and development, and the efficiency of farmers.

CONCLUSIONS AND POLICY IMPLICATIONS

Rice growers in Bangladesh are in an excellent position to meet the local demand for rice and to compete better in the international rice market. However, farmers need to increase their productivity levels, which is only possible by increasing their access to credit. We found that various factors significantly affected the technical efficiency of Boro rice farmers in Bangladesh, such as the educational level of the household head and diversified income sources.

We determined substantial adverse effects on the technical efficiency of rice growers due to interest rates and the partial quantity rationing of credit. Thus, we rejected our null hypothesis that the partial quantity rationing of credit did not affect the technical efficiency of Boro rice farmers in Bangladesh, and accepted the alternative hypothesis. Moreover, the average technical efficiency of farmers in the study region was 78%, thereby indicating the potential for increasing rice production by using the current production inputs more efficiently. Rural financial institutions should provide loans according to the particular requirements of debtors. At present, inadequate credit allocation leads to the limited distribution of resources, lower productivity, and even loan delinquency. By contrast, adequate loans could help improve the actual level of rice production, maintain and increase the incomes of farmers, reduce poverty, and ensure food security in Bangladesh. Future research might examine how the credit disbursement procedures of rural financial institutions could be improved to meet the real needs of borrowers.

Furthermore, our results suggest that is necessary to restructure government financial policy and private institutions to minimize the supply and demand gap in terms of credit constraints. Technical efficiency evaluations should also consider other institutional factors in addition to partial credit quantity rationing. Moreover, it should be possible to improve the technical efficiency of rice farmers in Pabna but it is not clear whether their development would help to make Bangladesh a global leader in rice production. Our empirical study demonstrated that the availability of credit to improve production is crucial for enhancing the technical efficiency of rice production in Pabna district, but we also consider that this problem is a major bottleneck in other districts of Bangladesh. Therefore, a comprehensive nationwide survey should be conducted to obtain similar information from a wide range of farm households in order to facilitate changes in existing government policies. The information obtained from a national survey could allow policy makers to develop detailed guidelines for rice producers and help implement appropriate measures to boost rice production in Bangladesh.

Declaration of competing interest

The authors declare no conflict of interest.

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Authors' contributions

Md Ghulam Rabbany and Jianchao Luo conceived and designed the research work; acquisition of data performed by Fazlul Hoque and Md Ghulam Rabbany; Md Ghulam Rabbany, Rana Roy, Mohammad Shakhawat Hossain, Kh Zulfikar Hossain and Tanwne Sarker analyzed the data; Md Ghulam Rabbany, Yasir Mehmood, and Arshad Ahmad Khan interpret the data; drafting the article by Md Ghulam Rabbany, Yasir Mehmood; Md Ghulam Rabbany, Mohammad Shakhawat Hossain, Rana Roy, Yasir Mehmood and Fazlul Hoque wrote and revised the manuscript; Critical revision of the article conducted by Jianchao Luo, Fazlul Hoque, Yasir Mehmood. All authors have read and approved the final manuscript.

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