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Effects of Credit Constraints on Technical Efficiency of Dragon Farmers: Evidence from the District of Jhenaidah and Chuadanga

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ABSTRACT: This study examines the impact of credit constraints on the technical efficiency of dragon fruit farmers in the Jhenaidah and Chuadanga districts of Bangladesh. The data was gathered from 160 dragon farmers in the Jhenaidah and Chuadanga districts of Bangladesh using a simple method of random sampling. Prior to carrying out a field survey, a theoretical model was developed to distinguish between dragon farmers who are bound by credit and those who are not constrained. The acquired data was analyzed in two steps. Firstly, we examined the technical efficiency of dragon farmers using the stochastic frontier model (SFA). Secondly, we employed an inefficiency effect model to evaluate the impact of credit constraints on technical efficiency. The findings suggest credit-constrained dragon farmers (CCDF), are 5.31% fewer technical skills compared to credit non-constrained dragon farmers (CNDF). The results also demonstrate that the educational level of the household head, the number of family members, the usage of certified seeds, the timing of sowing, access to agricultural extension services, income from non-farm activities, and the amount of savings in the household all have an important impact on the technical efficiency of both categories of dragon farmers. Moreover, the magnitude of the credit has a significantly positive effect, whereas the interest rate applied to the principal amount has a significantly adverse effect.

KEYWORDS: Dragon Farmers, Credit Constraints, Technical Efficiency, Farm Households, Bangladesh.

1. INTRODUCTION

Most of the population in Bangladesh resides in rural areas, and their primary source of livelihood is agriculture and related activities. According to the estimation of (Bangladesh Economic Review (2023), the overall contribution to the broad agriculture sector at the constant price was 11.20 percent of GDP in the financial year 2022-23. Moreover, around 45.33% of the country's overall labour power is in agriculture (Labor Force Survey, 2022).

Dragon is the recently introduced super fruit in Bangladesh. It is a nourishing and delightful exotic fruit grown in arid regions worldwide, particularly in Asian countries (Aryal et al., 2020). Its beautiful colour, delicious pulp with edible black seeds, health benefits, and strong export potential have made it extremely popular among farmers and consumers. The flower of the dragon is so beautiful that it is called 'Queen of the Night' (Gunasena et al., 2006 & Mori et al., 2023). The cultivation of this fruit is conducted on a commercial scale in several countries like Vietnam, Thailand, Malaysia, Taiwan, China, Sri Lanka, Israel, Australia, Nicaragua, and Central America (Research & Markets, 2020).

Access to credit is a key tool for agricultural growth and rural development (Li et al. 2016; Lin et al. 2019; Amanullah et al. 2020). On the one hand, the capital requirements of agricultural communities have experienced a significant increase in recent years. Conversely, formal financial institutions are wary to allocate funds to agriculture due to the inherent uncertainties in this sector (Arshad et al. 2017a, b). Farmers in developing countries rely extensively on both formal and informal lending sectors as a result of inadequate savings. The theory of production and financial structure highlights that providing credit options to financially constrained farm households can lead to improved overall productivity performance (Elahi et al. 2018).

It has been suggested in the existing literature (von Cramon-Taubadel and Saldias 2014; Chandio et al. 2019; Attipoe et al. 2020; Ekinci and Omay 2020; Long et al. 2020; Kattel et al. 2020) that farmers' performance is influenced by environmental factors and credit constraints in a variety of ways, which may result in a decrease in farm productivity. The financial market in developing countries is characterized by fragmentation. The failure of the system is due to the presence of asymmetric information, the impact of informal lenders, strict loan disbursement terms and conditions, and controlled monitoring among other factors (Bhattacharya et al., 2020). Despite the efforts of financial experts internationally to implement sustainable rural development programs through the provision of various financial services at subsidized rates, farming communities in many developing countries still lack sufficient access to formal credit (Dong et al. 2012; Li et al. 2018; Jin et al. 2019; Ma et al. 2019; Cao and Leung 2020; Okoruwa et al. 2020).

The current rural financial market in Bangladesh is characterized by significant imperfections, primarily due to a lack of knowledge, complex information, limited credit availability, monitoring challenges, high non-performing portfolio ratios (NPPs), and the prevalence of private money lenders. Furthermore, individuals seeking loans must furnish various legal and supporting documents, which vary based on the loan amount and the requested cash facility (Ma et al. 2019). The presence of these obstacles contributes to a demanding credit environment that can lead to decreased agricultural productivity (Bashir and Mehmood 2010; Mehmood et al. 2018).

The farming community in Bangladesh is confronted with numerous obstacles, such as a lack of modern production technology, water scarcity, poor soil salinity, and insect and pest attacks, even though dragon cultivations make a substantial contribution to the country's GDP (Ahmed et al. 2021; Rana and Moniruzzaman 2021; Sarkar et al. 2021).

Credit constraints can have both direct and indirect effects. Directly, they can impact farmers' ability to make purchases. Indirectly, they can influence farmers' risk aversion, which limits their willingness to take risks, such as investing in modern technologies (Shew et al. 2019; Duong and Thanh 2019; Carrer et al. 2020; Kattel et al. 2020). Thus, farmers that lack adequate cash or are financially restricted have been unable to attain optimal levels of productivity. Similar to other developing nations, farmers in Bangladesh have been caught in an endless cycle of poverty and indebtedness. From one perspective, they require financial assistance in order to acquire essential agricultural inputs (Bidisha et al. 2018; Long et al. 2020), at the same time, financial institutions are unwilling to give them loans because of the risks in the farm sector r (Arshad et al. 2017b; Mehmood et al. 2017).

Typically, loan applications are denied or approved for lower amounts by financial institutions. Financial institutions in rural Bangladesh carefully assess various factors when evaluating farmers' eligibility for loans, including their net worth, years of experience, property offered as collateral, and loan history. When farmers meet all these requirements, banks will consider approving loans at varying interest rates based on an equity ratio.

It appears that there is a lack of research on credit constraints and the technical efficiency of dragon farmers in Bangladesh. Additionally, the existing studies have failed to consider important variables in their analysis. Previous research has examined various issues and analysed the limitations on credit from both the perspective of borrowers and lenders. By carefully examining the gaps and taking into account the credit constraints on both the demand and supply sides, we were able to assess the technical efficiency of the farm households. Using the same approach as other researchers, we employed the stochastic frontier model (SFA) and inefficiency effects model to examine the technical efficiency of dragon farmers. Given the significance of technical efficiency and the financial limitations faced by farmers, we focused primarily on two questions:

a) Do credit constraints affect the technical efficiency of dragon fruits farmers?
b) Does access to credit affect the technical efficiency of dragon fruits farmers?

2. THEORETICAL FRAMEWORK TO IDENTIFY CREDIT-CONSTRAINED HOUSEHOLDS

Before conducting the field survey, the authors developed a theoretical framework and categorized dragon farmers into those with credit constraints and those credit non constraints. Scholars have observed that credit constraints arise from both the supply and demand sides (Boucher et al. 2008; Diana et al. 2010; Chiu et al. 2014; Mehmood et al. 2017; Beyhaghi et al. 2020). Demand-side credit constraints can arise from various factors such as insufficient household income, previous credit issues, lack of collateral or guarantee, and more. On the other hand, supply-side credit constraints occur when lenders do not provide enough loans to household farmers (Mehmood et al. 2017). When the loan provider determines that the farmers are unable to repay the principal or interest, there is a significant likelihood that the loan application will be denied. These fundamental factors are especially important in situations where financial markets are imperfect or interest rates are exceptionally high (Jana 2015).

According to the theoretical model, dragon farmers who received the full amount they requested from financial institutions were classified as credit non-constrained dragon farmers (CNDF). On the other hand, dragon farmers who received only a partial amount or had their loan applications rejected by financial institutions were classified as credit-constrained dragon farmers (CCDF). Furthermore, it was postulated that if farmers were granted the whole sought amount by financial institutions, they would be able to get agricultural supplies and invest in modern technologies, hence enhancing productivity. Conversely, farmers who did not receive sufficient loans would have been unable to obtain the optimal resources for production, leading to reduced efficiency.

Additionally, the following figure 1 illustrates the division among farmers who depend on credit, with one group consisting of farmers who have not sought credit, and the other group consisting of farmers who have applied for credit. Dragon fruit farmers who have applied for credit are categorized into three subgroups: There are three categories of farmers when it comes to credit applications. The first group, known as CNDF, consists of farmers who met all the requirements and were granted the full amount of credit they applied for. The second group includes farmers whose applications were not accepted for the full amount of credit, and some were even rejected outright. Lastly, there are farmers who approached private lenders directly for credit, with most of them successfully obtaining the loan, although a few farmers have yet to receive it.

Ultimately, the authors distinguished three categories of farmers: (i) credit-constrained farmers; (ii) credit-non-constrained farmers; and (iii) farmers who have refrained from applying for credit due to a sufficient amount of funds. Notably, the final category was omitted from the dataset.

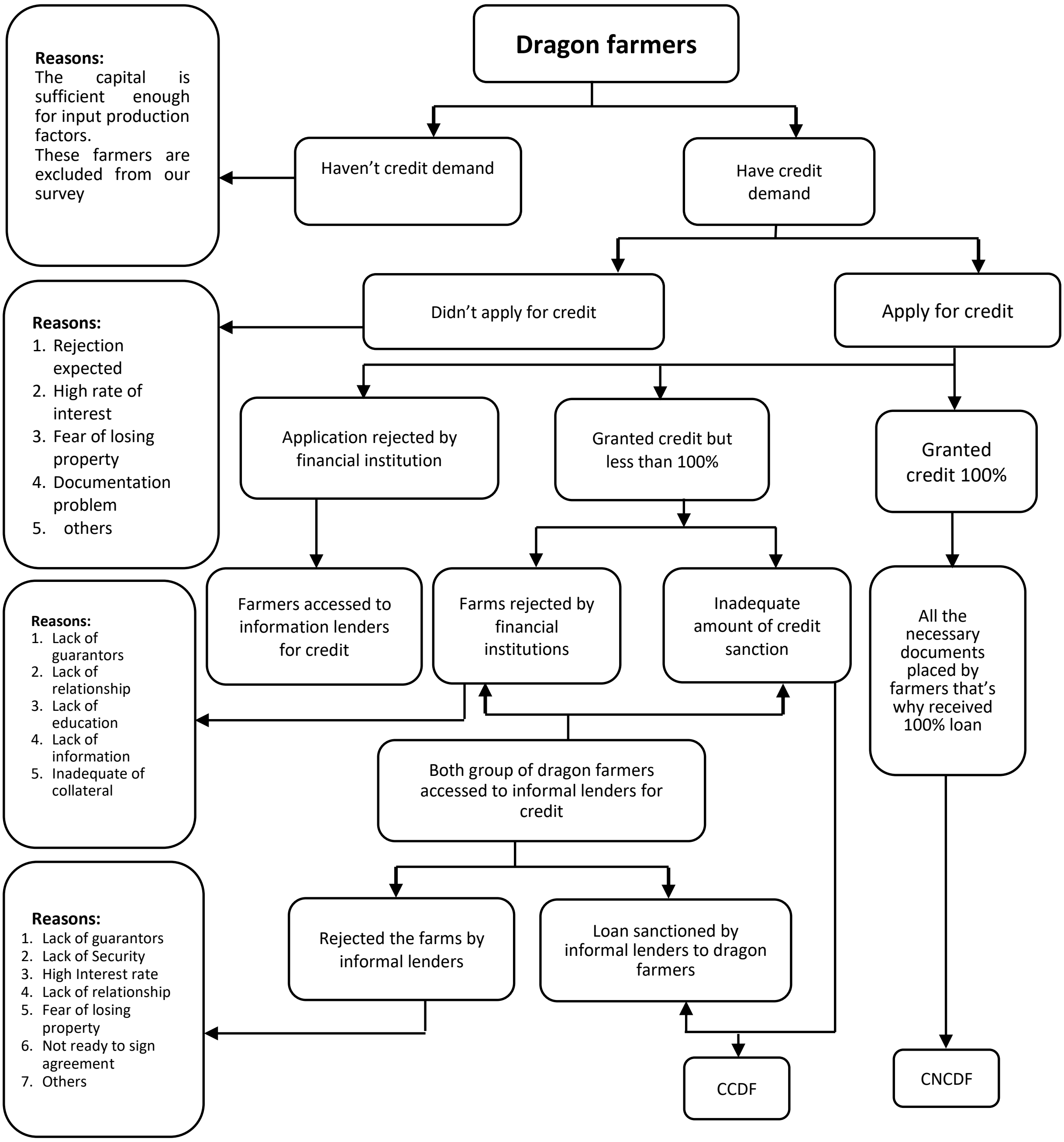

Figure 1: Theoretical model of credit constraints dragon farmers (CCDF) and credit non-constraints dragon farmers (CNDF)

The above figure highlights that dragon farmers experience significant barriers in accessing formal credit, primarily due to issues like lack of collateral, guarantors, and proper documentation. Those who apply for credit often face rejections, particularly due to high interest rates, fear of losing property, and insufficient relationships with financial institutions. Some farmers, aware of these challenges, choose not to apply at all, citing reasons such as high interest rates and the fear of rejection. Others turn to informal lenders, but these lenders also present their own set of challenges, including high-interest rates and a lack of collateral. Additionally, many farmers face exclusion due to insufficient information about available financial services, making it harder for them to access either formal or informal credit. On the other hand, some farmers who have sufficient capital for input production avoid seeking credit entirely. This indicates a deeper issue of financial exclusion, where farmers struggle due to institutional barriers and personal fears, leading to a reliance on informal and often exploitative lending systems.

3. METHODOLOGY OF THE STUDY

The methodology section of this research elucidates the chosen research design and approach employed to examine the effects of credit constraints on the technical efficiency of dragon fruit farmers in the Jhenaidah and Chuadanga districts of Bangladesh. It provides a comprehensive framework for data collection, analysis, and interpretation.

3.1. Study place and population

The study area, Jhenaidah and Chuadanga, is an agriculture-producing region situated in the country's South-Western portion. Most of the inhabitants of these districts live in rural areas, and they have been able to implement agricultural modernization practices. Apart from the usual agricultural products of Bangladesh, such as rice, wheat, potatoes, vegetables, sugarcane, battle leaf, lentils, garlic, onion, ginger, and fruits like mango, banana, jackfruits, guava, Dragon, plum, etc. are produced in the region. Among the agricultural products, fruits play a vital role in enhancing the economic status of farm households. The tropical fruit Dragon has become a new and attractive fruit to consumers and producers.

Moreover, the selection of dragon fruit cultivation was based on two primary reasons: firstly, the tropical fruit Dragon has become a new and attractive fruit to consumers and producers; and secondly, Dragon fruit cultivation in Bangladesh can positively impact on the country's growth.

Figure 2: Study area in Jhenaidah and Chuadanga District, Bangladesh.

3.2. Survey design and data collection

Primary data were collected through a household survey using structured questionnaires. A multi-stage random sampling was utilized to select the sample farm owners for the survey. In the first stage, the study randomly selected the two districts, and the next, we randomly selected four Upazilla from the two districts, Moshespur and Courtchadpur from Jhenaidh District and Jibonagar and Damurhuda from the Chuadanga district. After selecting four Upazilla from two districts, we purposively selected eight villages, Gaurinathpur and Aloampur from Mohespur; Fulhori and Somajkolla from Courtchadpur; Kasipur and Khayerhuda from Jibonnagar; and Perkrisnapur and Bastupur from Damurhuda Upazila. In the process of our study, we collected data from a total of 160 individuals who were engaged in Dragon fruit cultivation.

Notably, farm households who had neither applied for a loan nor faced credit issues in both categories were removed from the database because their loan demand from financial institutions was zero. A list of dragon farmers was obtained from the Agricultural Department of Bangladesh, and a total of 160 were interviewed. Thus, the total sample size is 160, including 56 CNDF and 104 CCDF.

3.3. Econometric estimation

3.3.1. Model Specification of Cobb Douglas Production Function:

The specification of the Cobb Douglas Production Function model is as follows:

$$\mathbf{Y_i = \beta_0\, X_1^{\beta_1}\, X_2^{\beta_2}\, X_3^{\beta_3}\, X_4^{\beta_4}\, X_5^{\beta_5}\, X_6^{\beta_6}\, X_7^{\beta_7}\, e^{u_i}}$$

The log linear form of the Cobb Douglas Production Function will be-

$$\mathbf{\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + \beta_7 \ln X_{7i} + u_i}$$

Where,

ln = Natural logarithm

Y_i = Gross income of the ith farm (Tk/Bigha/Year)

X_{1i} = Farm land area
X_{2i} = Labour cost of the i-th farm (Tk/Bigha/Year)
X_{3i} = Cost of seeding of the i-th farm (Tk/Bigha/Year)
X_{4i} = Irrigation cost of the i-th farm (Tk/Bigha/Year)
X_{5i} = Cost of pesticides of the i-th farm (Tk/Bigha/Year)
X_{6i} = Cost of fertilizer of the i-th farm (Tk/Bigha/Year)
X_{7i} = Cost of the Piller, rope and wire (Tk/Bigha/Year)
$\beta_i = \beta_0$ to β_6 are unknown parameters and
u_i = the disturbance term

3.3.2. Stochastic frontier analysis

The technical efficiency of rice growers was assessed using the SFA, which was introduced by Aigner et al. (1977). This model has been extensively employed in previous research (Tipi et al. 2009; Cabrera et al. (2010); Heriqbaldi et al. (2015); Bhattacharyya and Mandal (2016); Hasnain et al. (2016). The fundamental equation is as follows:

$$Y_i = f(X_i; \beta)\exp^{(v_i - u_i)} \ldots\ldots\ldots\ldots\ldots\ldots. (1)$$

Where,

Y_i = expected output of ith dragon farmers
X_i = observed function of inputs or descriptive variables
$(X_i; \beta)$ = framework's production frontier
v_i = random deviation of output
u_i = a set of non-negative random variables

Considering the distribution assumption of variance (v_i) and (u_i), we generated an assessment of (u_i), from its restrictive probability by generating the standard integral:

$$E(u_i|\varepsilon_i) = u_i^* + \sigma_i^* \left[\frac{\varphi\left(-\frac{u_i}{\sigma_i^*}\right)}{1-\varphi(-{u_i}/{\sigma_i^*})}\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where,

$u_i^* = (u\sigma_v^2 + \epsilon_i\sigma_u^2)/(\sigma_v^2 + \sigma_u^2)$

$\sigma_v^{*2} = \sigma_v^2\sigma_u^2/(\sigma_v^2 + \sigma_u^2)$ and $\varphi(.)$ denotes accumulative distribution and likelihood density functions. The variance value was determined by exchanging the values of (v_i) and (u_i) in Eq. (1). the estimation of $\varepsilon_i\sigma_i$ and l, which is associated with output-related (TE_i) of ith dragon cultivators. The output level is defined as the ratio of the perceived output to the highest possible production, represented by exp - vi and expressed as follows:

$$TE_i \frac{y_i}{f(X_i; \beta)e(v_i)} \exp^{\{-(u_i I \epsilon_i)\}}$$

$$TI_i = 1 - TE_i \ldots\ldots\ldots\ldots (3)$$

The estimated TE of dragon cultivators was restricted to a range of 0 to 1 by the distribution of (u_i) from Eq. (3). Consequently, we obtained the efficiency score from a variety of dragon producers in order to conduct our research. Moreover, the SFA framework's general structure is described below in order to evaluate the TE of dragon farmers:

$$\ln Y_i = \beta_0 + \sum_{K=i}^{\sigma} \beta_{ij} \ln X_{ij} + v_i - u_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where,

Y_i = The aggregate output for the dragon farmers
X_{ij} = The selected input variables explained as

X_1 = farmland area, X_2 = cost of seedling, X_3 = farm labor cost, X_4 = the cost of fertilizer application, X_5 = cost of pesticides, X_6 = irrigation cost and β_0 = coefficients of descriptive variables.

In the second phase of the comprehensive investigation, the authors utilized the inefficiency effects model to assess the technical efficiency of dragon farmers. Battese and Coelli (1995) developed by the research conducted by Aigner et al. (1977) and established the inefficiency effects model using the stochastic frontier analysis (SFA). We employed the inefficiency effects model utilizing the maximum likelihood estimation method.

$$IE_i = \delta Z_i + u_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where IE_i = inefficiency scores, Z_i = vector of designated variables that impacts inefficiency within different classified groups of dragon farmers, and u_i is a random error term in the database set,

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

The data set presented provides a summary of various cost components associated with farming, specifically measured per Bigha per year, along with the gross income generated by the farm. The data includes the mean (average), standard deviation (Std. Dev.), minimum (Min), maximum (Max), and the number of observations (Obs) for each variable. Let's break down each component:

Table1: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max	Obs
Gross income of the farm (Tk/Bigha/Year)	611868.8	81414.39	400000	785000	160
Labour cost of the farm (Tk/Bigha/Year)	113815.6	5788.902	101000	125000	160
Land Preparation cost of the farm (Tk/Bigha/Year)	6480.313	369.1354	5400	7200	160
Cost of seed of the farm (Tk/Bigha/Year)	53035.94	2514.168	44000	58000	160
Irrigation cost of the farm (Tk/Bigha/Year)	12438.13	885.9399	10000	14200	160
Cost of pesticides of the farm (Tk/Bigha/Year)	44168.75	1915.123	40000	48000	160
Cost of fertilizer of the farm (Tk/Bigha/Year)	93188.75	6894.816	75000	112000	160
Cost of the Piller, rope and wire (Tk/Bigha/Year)	11444.69	885.4093	10000	13500	160

Source: Author's Estimation

This indicates that, on average, the farm generates an income of 611868.8 Tk per Bigha per year, with a variability (standard deviation) of 81414.39 Tk. The income ranges from a minimum of 400000 Tk to a maximum of 785000 Tk across 160 observations. On average, the labour cost per Bigha per year is 113815.6 Tk, with a standard deviation of 5788.902 Tk, indicating some variation around this mean. The labour cost ranges from 101000 Tk to 125000 Tk.

The average cost for land preparation is 6480.313 Tk per Bigha per year, with a relatively low standard deviation of 369.1354 Tk, suggesting consistent costs across observations. The range is from 5400 Tk to 7200 Tk.The average seed cost is 53035.94 Tk per Bigha per year, with a standard deviation of 2514.168 Tk. The costs range from 44000 Tk to 58000 Tk. The average irrigation cost is 12438.13 Tk per Bigha per year, with a standard deviation of 885.9399 Tk. The irrigation costs range from 10000 Tk to 14200 Tk.

The average fertilizer cost is 93188.75 Tk per Bigha per year, with a standard deviation of 6894.816 Tk. The costs range from 75000 Tk to 112000 Tk. The average cost for pillars, rope, and wire is 11444.69 Tk per Bigha per year, with a standard deviation of 885.4093 Tk. The costs range from 10000 Tk to 13500 Tk.

4.2. Estimation of Cobb-Douglas Production Function

The following table 1 represents the gross outcome of the Cobb-Douglas production function for two districts together.

Table 2: Estimation of Cobb-Douglas Production Function Jhenaidah and Chuadanga District

Jhenaidah and Chuadanga District				
Method: Ordinary Least Squares				
Dependent variable: Total Revenue/Output (lnY)				
Number of Observation: 160 (farm owners)				
Explanatory Variables	**Coefficients**	**Std. Err.**	**t-Statistic**	**Probability**
C	-13.46987	1.322343	-10.18637	0.0000
Farm land area ($\ln X_1$)	0.028141	0.093947	4.891917	0.0000
Farm Labor Cost ($\ln X_2$)	0.671705	0.119479	5.621970	0.0000
Seedling Cost ($\ln X_3$)	0.225424	0.118644	1.899999	0.0593
Irrigation Cost ($\ln X_4$)	-0.190789	0.084336	-2.262258	0.0251
Pesticide Cost ($\ln X_5$)	-0.044715	0.187518	-0.238456	0.8118
Fertilizer Cost ($\ln X_6$)	0.165047	0.084155	1.961234	0.0417

Cost of the pillar-rope-wire (lnX_7)	-0.214071	0.070444	-3.038875	0.0028
R-squared	0.825248			
Adjusted R-squared	0.817200			
F-Statistic	102.5433			
Prob (F-Statistic)	0.000000			

Source: Estimated by EViews 10 using survey data

The estimated results indicate that labor, land preparation, irrigation, and fertilizer costs exhibit statistically significant positive impacts. In contrast, the cost of the pillar rope wire has a statistically significant negative impact on farmers' income. Among these factors, labour emerges as the most influential, with a 1% increase in labour cost correlating to a significant 178.91% rise in farmers' income. Following closely, land preparation stands out as the second most crucial factor for dragon fruit cultivation, where a 1% increase in land cost, with other factors held constant, leads to a substantial 67% increase in farmers' income. The coefficient of R-square 0.825248 represents that the explanatory variables can explain 83% of the variation in the farmer's income from dragon fruit cultivation. The F-statistic value is positive (102.5433), and its respective probability value is less than 5%, indicating that all the factors have a combined positive impact on the income/output of Dragon fruit cultivation.

4.3. Maximum likelihood estimates of the production frontier

Table 3: Maximum likelihood estimates of production frontier

Variables	CNDF No. (56)	CCDF No. (104)	Full sample No. (160)
Intercept	0.577 (0.070) ***	0.731 (0.094) ***	0.785 (0.063) ***
Ln farm land area	0.032 (0.009) **	0.088 (0.011) **	0.082 (0.008) ***
Ln cost of seedling	0.560 (0.050) ***	0.489 (0.064) ***	0.491 (0.044) **
Ln farm labor cost	0.010 (0.008)	0.045 (0.011) **	0.039 (0.010)
Ln cost of fertilizer	0.129 (0.029) ***	0.151 (0.040)	0.066 (0.008) *
Ln cost of pesticides	0.095 (0.015) **	0.048 (0.017) **	0.058 (0.010) ***
Ln irrigation cost	0.064 (0.023) **	0.064 (0.035)	0.021 (0.013)
Ln σ^2	−10.828(0.184) ***	−8.358 (0.112) ***	−7.969 (0.095) ***

Notes: The values in parenthesis specify standard errors. Significant level at ***p=1%; **p=5%, and *p=10%

The table 3 displays the data indicating that the coefficients for the farmland area variables are 0.032 and 0.088 for CNDF and CCDF, respectively. The coefficient value indicates that a 1% increase in the unit of farmed area leads to an estimated increase in dragon yield by 0.03% for the CNDF and 0.08% for CCDF. When considering the cost of seedlings, we observe the greatest impact on dragon production. The predicted elasticities for CNDF and CCDF are 0.56 and 0.489, respectively. A key contributor is that the majority of farmers in the study area utilized higher-grade seeds for dragon production, resulting in a substantial and positive increase in dragon yield.

The coefficient value for agricultural labour cost in the CCDF model is 0.045, and it is statistically significant at a 5% level of probability. The coefficient values for the cost of fertilizer in CNDF and CCDF are 0.129 and 0.151, respectively. The coefficients for the cost of pesticides values are 0.095 for CNDF and 0.048 for CCDF, respectively. The coefficient value of the irrigation cost for CNDF is 0.064 and statistically significant at the 5% level of probability. However, for CCDF, the same coefficient value is not statistically significant.

4.4. Range of technical efficiency

The following table shows the results of the mean technical efficiency of CNDF and CCDF.

Table 4: Efficiency estimates of credit constrained, credit non-constrained, and full sample size

Efficiency range	CNDF (N=56)		CCDF (N=104)		Full sample (N=160)	
	Numbers	Percentage	Numbers	Percentage	Numbers	Percentage
<80%	14	25.50	56	53.51	66	41.22
81–85%	9	14.00	20	19.45	30	18.94
86–90%	10	17.50	8	7.56	15	9.29
91–95%	13	23.50	11	11.08	28	17.19
>95%	10	19.50	9	8.37	21	13.33
Total	56	100	104	100	160	100
Mean	0.9167	91.67%	0.8636	86.36%		

Source: author's estimation

According to the findings, the average technical efficiency of CNDF is 91.67% and 86.36% for CCDF (Table 4). The difference in the average technical efficiency is 5.31%, suggesting that there are gaps in technical efficiency between CNDF and CCDF. Thus, in both situations, the rice cultivators may enhance the efficiency level by 8.33% for CNDF and 13.64% for CCDF, utilizing the existing quantity of resources. In South Asia, the range of technological efficiency ranged between 0.82% and 0.97% (Bibi et al., 2020).

4.5. Technical inefficiency effects estimate

The technical inefficiency of dragon cultivators is influenced by the factors listed in Table 5. The authors illustrated the results of the inefficiency effects model with respect to technical efficiency, abiding to the methodologies of Cabrera et al. (2010) and Mehmood et al. (2017). This suggests that technical efficiency is positively influenced by a negative impact on technical inefficiency. The parameters that were calculated indicate that the chief age of the household (which is regarded as agricultural farming experience) has a substantial but detrimental impact on CNDF. The negative sign indicates that the productivity of older farmers in the surveyed location is lower than that of their younger counterparts. The education level coefficients in both categories of growers are positive and significant; however, the effect appears to be more pronounced on CNDF. The coefficient of household size is both positive and significant for both categories of farmers. This suggests that the technical efficiency of producers increases as the size of their households increases. This may be attributable to the fact that a greater number of family members are involved in agricultural practices and assist farmers in the management of farm activities. The coefficients of certified seed for both CNDF and CCDF are both positive and statistically significant.

Table 5: Parameter estimates of inefficiency effects model

Variables	CNRG No. (56)	CCRG No. (104)	Full sample No. (160)
Constant	−6.571 (0.868) ***	−3.882 (0.570) ***	−4.597 (0.441) ***
Household head age(years)	0.025 (0.022) **	0.007 (0.008)	0.014 (0.007)
Household head education (years)	−0.103 (0.036) ***	−0.078 (0.037) **	−0.086 (0.029) **
Household family size (numbers)	−0.066 (0.017) **	−0.060 (0.029) **	−0.064 (0.023) **
Certified seed (yes=1; otherwise=0)	−0.751 (0.595) **	−0.690 (0.345)	−0.683 (0.280) **
Sowing time (yes=1; otherwise=0)	−0.968 (0.276) ***	−0.748 (0.376) *	−0.453 (0.275) **
Owned tube-well (yes=1; otherwise=0)	0.523 (0.336)	−0.682 (0.396)	−0.075 (0.314)
Extension services (yes=1; otherwise=0)	−0.887 (0.285) **	−0.709 (0.354) **	−0.748 (0.215) **
Livestock holding (yes=1; otherwise=0)	−1.422 (0.425) **	−0.512 (0.338) *	−0.909 (0.260) **
Off-farm income (yes=1; otherwise=0)	−0.790 (0.495) **	−1.074 (0.472) **	−0.876 (0.343) *
Household savings (1000 BDT)	−0.002 (0.026) **	−0.002 (0.001) **	−0.002 (0.001) **
Credit size	−0.0002 (0.0002) **	−0.0003 (0.0001) **	−0.003 (0.0001) *
Interest rates (percentage)	0.017 (0.014) **	0.030 (0.011) **	0.026 (0.009) *
Credit availability (yes=1)	--	--	−0.456 −0.273**

Notes: The values in parenthesis specify standard errors Significant degree at ***p< 1%; **p< 5%, and *p< 10%

Both the CNDF and CCDF groups are affected by the credit size indicator in significant ways for the better. There are two clear ways to see how the amount of credit affects things. At first, raising the amount of credit would encourage farm households to use new technologies and help them distribute their resources in a smart way.

Basically, the comprehensive assessment of the sample parameters is similar to that of CNDF and CCDF to some extent. The primary objective is to evaluate how credit constraints impact the technical efficiency of farmers. After carefully analyzing multiple studies, we evaluated credit availability as a binary variable. Technical efficiency is influenced by the availability of credit, which was evaluated using the direct elicitation method. Based on the analysis, it is evident that the presence of credit has a significant and positive effect on the technical efficiency of dragon fruit farmers.

5. CONCLUSIONS AND POLICY IMPLICATIONS

An investigation was conducted to examine the impact of credit constraints on the technical efficiency of dragon farmers. The study utilized cross-sectional data obtained from the Jhenaidah and Chuadanga districts in Bangladesh. The authors employed the method of direct elicitation to categorise dragon farmers into two distinct groups: CCDF and CNDF. A simple random selection method was utilized to select a total of 160 farm households in order to gather the required information. The SFA was employed to assess the technical efficiency of dragon farmers. The average technical efficiency of CNDF is 91.67% and CCDF is 86.36%. The findings suggest that the CNDF and CCDF might potentially improve their technical efficiency by 8.33% and 13.64%, respectively, based on the survey conducted in the area. The disparity in technical efficiency scores between CNDF and CCDF is 5.31%.

Furthermore, the results of the inefficiency effects model indicate that the technical efficiency of both groups of dragon farmers is influenced by factors such as the level of education, the size of the household, the timing of sowing, the availability of extension services, earnings from non-farming activities, and the savings of the household head. The credit size variable has a positive impact, but the interest rates on the principal amount have a significantly negative impact on the technical efficiency of dragon cultivation.

Our research indicates that having access to formal credit assistance can alleviate financial constraints for households, enabling them to afford necessary farm inputs. Thus, it is imperative for the government and private financial organizations to simplify the loan process and lower the interest rate for agricultural businesses. In addition, it is crucial for the government to raise the credit limit per acre, taking into account the financial needs and input expenses. It would be helpful to financial institutions to consider opening branches in remote areas of Jhenaidah and Chuadanga District. This would help farmers access the services they need and potentially contribute to an increase in the institutions' loan portfolio.

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