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## Article

# Does credit constraint matter for technical efficiency, technological shifts, and profitability of flower growers? An empirical study

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## Does credit constraint matter for technical efficiency, technological shifts, and profitability of flower growers? An empirical study

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### ABSTRACT

This study aims to investigate the variations in efficiency, technology gap, and profitability of flower producers depending on their credit constraint position. A total of 160 flower farmers have been selected from Bangladesh by using a multistage sampling technique. Meta-frontier Data Envelopment Analysis (DEA) is employed to estimate the efficiency differences and technological gaps depending on the credit constraint situation. At the same time, the Tobit regression model is used to estimate the factors influencing the meta-technical efficiency of flower farmers. Profitability differences depending on the credit constraint situation are identified using the gross margin and benefit cost ratio. The mean meta-technical efficiency for Marigold farmers is highest when unconstrained (0.73) and lowest when credit is constrained (0.64) relative to the meta-frontier, which indicates output could be increased by 27 and 36%, respectively, without increasing input. On the other side, the efficiency of credit-unconstrained rose farmers is slightly higher than that of constrained rose farmers. In addition, credit-constrained marigold farmers achieve the lowest technological gap ratio (0.64) compared to credit-unconstrained farmers. Sociodemographic and farm characteristics such as education, source of seed, land tenure, farm area, and age have a significant positive impact, while earning family members, types of flowers, and credit constraints have a significant negative effect on the technical efficiency of flower farmers. The profitability of credit-unconstrained marigold and rose farmers is higher than that of credit-constrained farmers. Facilitating the loan application process, easing the pre-conditions of loan acceptance, and adjusting the repayment schedule help to remove the credit-constrained situation.

### IMPACT STATEMENT

Bangladesh's floriculture industry has significant potential, but small-scale farmers face challenges due to limited access to credit. High interest rates and strict collateral requirements hinder their ability to improve technical efficiency, technological gap, and profitability. This study addresses the often-overlooked impact of credit constraints on flower farmers' efficiency, technological gap, and profitability. Farmers with access to credit are more efficient, as timely investment in inputs increases productivity and profitability. In contrast, limited credit access hampers input application, reducing both productivity and technical efficiency, trapping farmers in low-profit cycles, and increasing the technological gap. Researchers interested in the financial constraints in agriculture and their effect on productivity, efficiency, and profitability can gain valuable insights from this study. It also emphasizes the need for policymakers to enhance access to affordable credit by lowering interest rates and easing collateral requirements, which will help boost productivity and support the sustainable growth of Bangladesh's floriculture sector.

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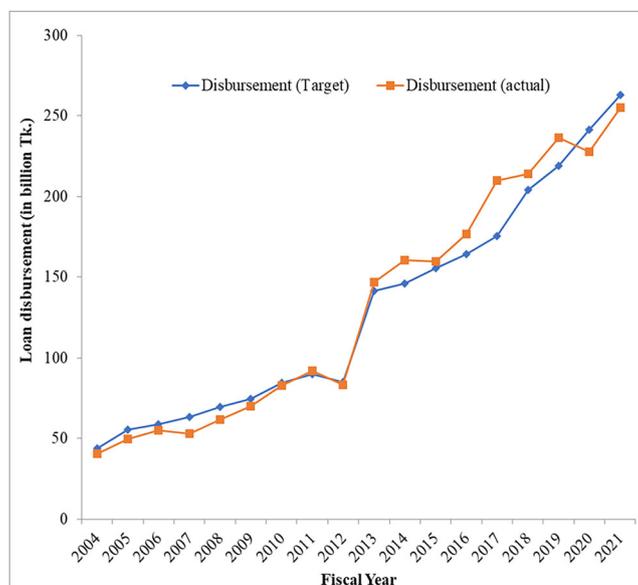
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## 1. Introduction

Globally, the floriculture industry has experienced dramatic change within the past few decades regarding productivity and modern technology adoption in flower farming (Mitra et al., 2022). It has become a lucrative sector because of its contribution to employment generation, livelihood development, and reducing inequality and poverty due to its greater potential for export and revenue earnings from comparably lower capital investments (Tizazu & Workie, 2018). Because of the business opportunities it presents, the competitive dynamic is changing, and production is transferring to developing nations (Çürük & Alptekin, 2022). Bangladesh has had an enormous change in the floriculture sector over the past few years. Farmers have made a revolution in recent years. The floriculture industry has grown by almost 15% per year, generating Tk 1600 crore in annual turnover in Bangladesh. The flower society has claimed that 95% of production can meet domestic demands and the rest, 5% is exported to China and other countries (Sohel, 2022). Almost 3930 hectares of land have been used for flower cultivation in recent years, whereas only 931 hectares of land were used in FY2009-10 (BBS, 2009–2010; BBS, 2020–2021). Commercial flower farming requires huge capital investment because of the intensive use of modern inputs which are relatively more expensive (Adesina & Zinnah, 1993; Ahmed & Hasan, 2007; Doss & Morris, 2001; Quagraine et al., 2010). This industry creates bedding, garden plants, potted flowering plants, cut flowers, and floriculture products, which increases the necessity of modern inputs manifold (Mony et al., 2018). Due to a lack of capital, farmers are unable to afford the increasing expenses of farming. Farmers in developing countries often live below the poverty line and their financial condition cannot afford the massive capital requirement (Reardon & Vosti, 1995). Moreover, the productivity of crops depends on timely input use (Mitra et al., 2019; Begum et al., 2023). Therefore, access to credit is imperative for running an effective, successful, and profitable flower farm (Carlisle et al., 2019). Nevertheless, it appears that the current flow of capital is insufficient for flower farming. In recent years, actual credit disbursement has been slightly higher than targeted but not as much as demanded (Figure 1).

Institutional credit in Bangladesh is generally provided by government and private banks and non-government organizations (Mehedi et al., 2020). Institutional and non-institutional credit is available for the farmers but not to an extent where it can meet the demand (Mitra et al., 2019). Non-institutional credit is provided in very small amounts for arranging social rituals (marriage, funerals, etc.) but it is not intended to provide big loans for flower growers (Chen, 2003; Feder et al., 1990). Therefore, institutional credit is the key source for flower farming but collateral is the precondition for receiving institutional credit. The farmer uses their farmland, farmhouse, and other durable properties as collateral (Tamura & Tabakis, 2013). However, most farmers do not have such types of assets that can be used as collateral,



**Figure 1.** Actual and targeted credit disbursement in agriculture Source: Bangladesh Bank 2004–2021.

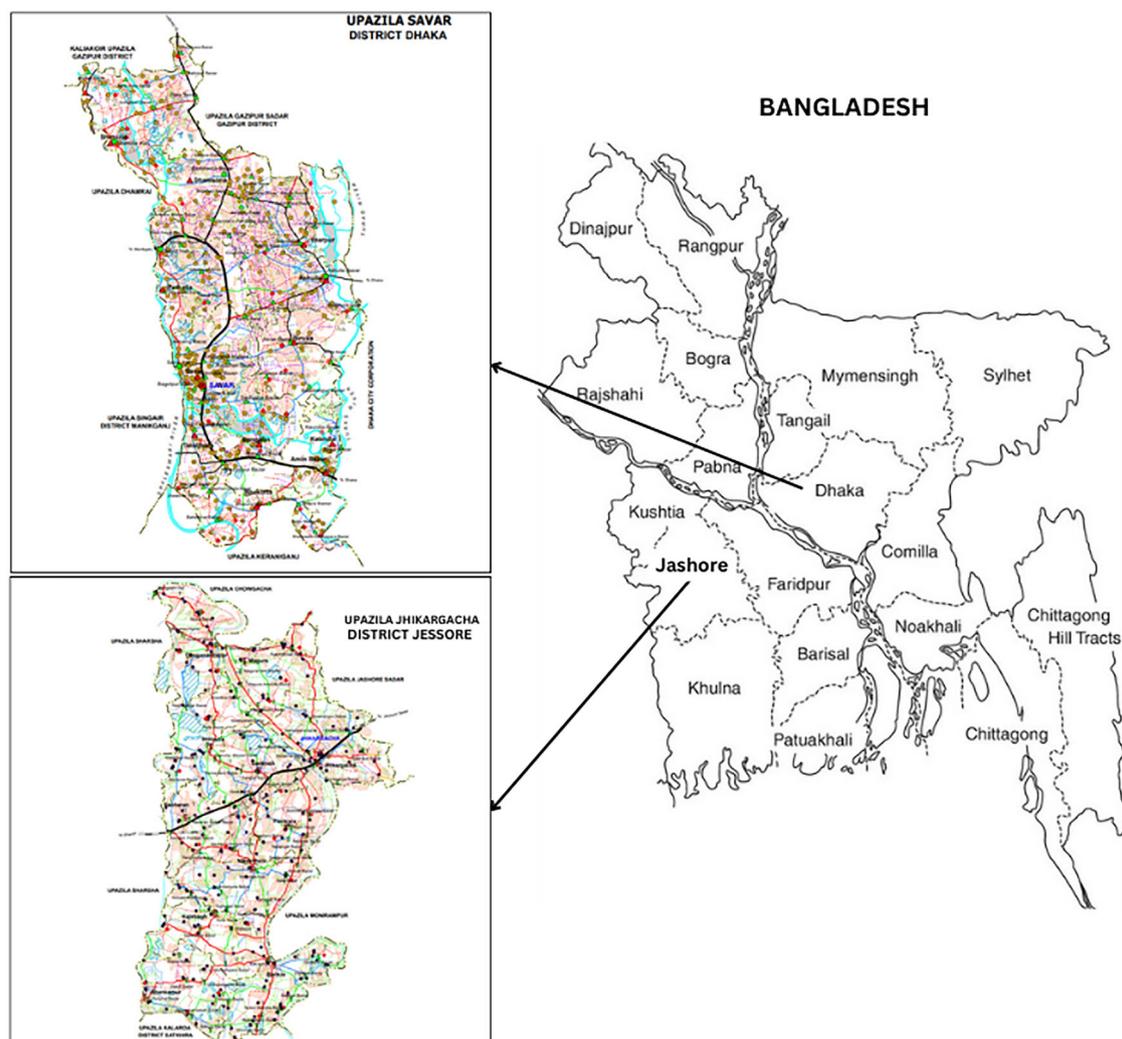
which leads to a credit constraint situation (Feder et al., 1988). According to earlier studies on agriculture, credit constraints have significant negative effects on farm output, technology adoption, farm investment, and farm profit (Antwi et al., 2017; Engle & Kumar, 2011; Ly & Nguyen, 2014). In most cases, credit-constrained farmers are unable to differentiate between flower production expenses and family consumption expenses, which certainly influence their optimal input uses. Consequently, credit-constrained farmers have less productivity than unconstrained ones and have less profitability, efficiency, and savings (Amanullah et al., 2020; Mitra et al., 2019). Low savings lead to low investment in durable assets. The lack of investment in durable properties reduces the collateral of the farm and further increases the credit constraint problem (Fernández-Villaverde & Krueger, 2011). It is difficult for a constrained farmer to overcome the vicious circle (Mitra et al., 2019). So, in this study, we are going to answer the following questions: Are there any differences in profitability, efficiency, and technological gaps among flower farmers depending on the credit-constrained situation? This study is carried out in two districts of Bangladesh because these districts contribute more than 80% of the total flower production of Bangladesh and lack of credit access is a crucial problem all over the country (BBS, 2020–21; Mitra et al., 2019).

However, several studies have examined the profitability and livelihood effects of floriculture in developing countries. Setu (2018) investigated the influence of flower farming on farmers' livelihoods in the Jhenaidah district of Bangladesh. They found that 76.5% of farmers gained medium livelihood improvement through flower cultivation, while 13.9% had a high impact on flower producers' livelihood. Yeung and Yee (2010) investigated the determinants of consumers purchasing preferences at the flower market and found that distinct packaging, healthy products, special price offers, and free sample tastings have the highest influence on purchasing intention. Raha and Siddika (2004) examined the existing marketing system, marketing cost, and margins of different flowers from different marketing channels and found that flower farmers received 30.75 to 60.42% of the consumer's taka, while 24.71 to 58.5% were spent as the marketing cost. In addition, Singh et al. (2014), Mou (2012), and Momotaz and Banik (2020) focused mainly on the market price and profitability of different flowers. Mitra et al. (2022) investigated the effects of the COVID-19 pandemic on the satisfaction level of flower farmers, market prices, farm income, profitability, efficiency, and technological shifts of flower farmers in Bangladesh. Kumar et al. (2023) identified the economic viability of different techniques of flower drying along with influencing factors like efficiency, economic feasibility, flower waste management, and sustainability. Chowdhury and Khan (2015) and Laboni et al. (2019) studied the export potentiality of different flowers. The above discussions provide significant shreds of evidence that flower farming is highly profitable, which assists in improving the livelihood of flower farmers. However, the effect of credit constraints on the efficiency, technological gap, and profitability of flower farmers remains ignored. This study is going to enrich the literature regarding the financial access of flower farmers as well as its effect on their technical efficiency, technological gap, and profitability.

## 2. Methodology

### 2.1 Study area, sample size, and data collection

This study is carried out in the Jashore and Savar districts of Bangladesh, which are well-known for their floriculture. Multi-stage sampling procedures were followed for data collection. In the first stage, the data were collected from two flower-producing districts of Bangladesh, namely, Jashore and Dhaka. These districts capture more than 80% of the total flower production in Bangladesh, which is shown in Figure 2. The total population size of flower farmers is about 7000 (BBC, 2021). In the second stage, upazila-level flower production and farm information were collected from the District Agriculture Officer, and two upazilas (Jhikargacha and Savar) were selected from these two districts based on the production volume. Finally, flower farm lists were collected from the Upazila Agriculture Officer from all upazilas, and a total of 160 flower farms (rose and marigold) were selected randomly, of which 59 farmers were credit constraints and 101 were credit-unconstrained. Rose and marigold farmers have captured more than 80% of the flower market in Bangladesh (BBS, 2020–21). Data has been collected using a pre-tested questionnaire. The interview schedule includes information on farm and off-farm income



**Figure 2.** Study areas selected in Bangladesh.

conditions, the input used and output produced, the market price of flowers, problems faced during flower farming, satisfaction level about input-output quantity, price of flowers, and customers' availability. The face-to-face interview method was applied to collect the data. A few fully trained and experienced graduate students were involved in data collection from the flower farmers.

## **2.2 Analytical techniques**

### **2.2.1 Identifying the technical efficiency and technological gap differences depending on credit constrained situation**

Meta-frontier Data Envelopment Analysis (DEA) is used to identify the efficiency and production possibility differences depending on credit-constrained situations (Charnes et al., 1994; Cooper et al., 2002). Two separate production functions are formed for credit-constrained and unconstrained flower farms. These frontiers are known as group frontiers to compare the performance across the farms within each group (Asmild, 2015; Jiang & Sharp, 2015; Mitra et al., 2022). An additional production frontier is designed by pooling both constrained and unconstrained farmers. This frontier is formed, known as the meta frontier (MF), to compare performance across the groups. The output-oriented model is employed to identify the efficiency differences. The output-oriented model can be defined as If group  $h$  (here  $h=1, \dots, 2$ ) consists of data on  $L_h$  farms the linear programming (LP) problem solved for the  $i$ th farm can be constructed as follows (Bogetoft & Otto, 2010):

$$ME_i = 1/\text{Max}_{\lambda, \varphi} \Theta,$$

such that,

$$\begin{aligned} -\Theta y_i + Y_h \lambda &\geq 0 \\ x_i - X_h \lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \quad (1)$$

where,  $y_i$  and  $x_i$  are the  $M \times 1$  and  $N \times 1$  vector of outputs and inputs of the  $i$ th Decision-Making Units (DMUs), respectively;  $Y_h$  is the  $M \times L_h$  matrix of output quantities for all  $L_h$  units, and  $X_h$  is the  $N \times L_h$  matrix of input quantities for all  $L_h$  units;  $\lambda$  is an  $L_h$  vector of weights and  $\Theta$  is scalar providing the information on technical efficiency (Managerial Efficiency) of the  $i$ th farm.

In the case of meta-frontier, the above Linear Programming (LP) is re-run with the same input and output matrices containing data for all DMUs from both groups,  $L = \sum_h L_h$ , that is,

$$MTE_i = 1/\text{Max}_{\Theta', \lambda'} \Theta',$$

such that

$$\begin{aligned} -\Theta' y_i + Y^* \lambda' &\geq 0, \\ x_i - X' \lambda' &\geq 0, \\ \lambda' &\geq 0, \end{aligned} \quad (2)$$

where,  $y_i$  and  $x_i$  are the  $M \times 1$  and  $N \times 1$  vector of output and input quantities, respectively, for the  $i$ th unit:  $Y'$  and  $X'$  are the  $M \times L$  and  $N \times L$  matrix of output and input quantities, respectively, for all  $L$  units;  $\lambda'$  is an  $L \times 1$  vector of weights, and  $\Theta'$  is a scalar.

In this approach, both managerial efficiency and meta-technical efficiency (TE) scores can be calculated. Managerial efficiency (ME) is assessed by the distance between each DMU and its group frontier, whereas meta-technical efficiencies (MTE) are determined by the distance between each DMU and the MF. The distance between the DMU's group frontier and the meta-frontier can also be measured as the technology gap ratio (TGR) for each observation. The equation is as follows:

$$TGR_i^h = \frac{MTE_i}{ME_i} \quad (3)$$

The lower difference in production possibilities between group and meta-frontier is indicated when the mean TGR is closer to 1.

### 2.2.2 Determinants of technical efficiency

As the efficiency score relative to the meta-frontier varies from 0 to 1, determinants of technical efficiency cannot be estimated efficiently by using ordinary least squares (Alam, 2011; Kaliba & Engle, 2006; Wooldridge, 2012). Hence, the Tobit regression model is better for this analysis (Jehu-Appiah et al., 2014; Prodhan & Khan, 2018). We used the instrumental variable Tobit regression model because the model incorporated endogeneity. Farmers' collateral is employed as an instrumental variable, while credit constraints are an endogenous variable. Since it is anticipated that collateral will have an indirect impact on the dependent variable (efficiency score) and a direct impact on the endogenous variable (Credit constraints), we have used it as an instrumental variable. The empirical instrumental variable (IV) Tobit regression is as follows:

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + u_i \quad (4)$$

where  $Y$  = Efficiency of flower farmers;  $X_1$  = Farm area (decimal);  $X_2$  = Age (Years);  $X_3$  = Training (in days);  $X_4$  = Earning family members (numbers);  $X_5$  = Education (Years of schooling);  $X_6$  = Source of seed (If own = 1, Buy = 0);  $X_7$  = Land tenure system (Owned = 1, Cash tenant = 0);  $X_8$  = Credit constrained (If constrained = 1, unconstrained = 0);  $X_9$  = Types of flower (If Marigold = 1, Rose = 0);  $X_{10}$  = Off farm income (If yes = 1, otherwise = 0) and  $u_i$  = error term.

### 2.2.3 Identify the profitability differences between the credit constraint and unconstrained farmers

Besides, profitability differences between Marigold and Rose depending on credit-constrained situations have been identified by using gross return, gross margin, Benefit-Cost Ratio (BCR), and break-even point. We have separately analysed the profitability of marigold and rose because they are annual and perennial flowers, respectively. Total variable costs such as labour, seedlings, fertiliser, insecticides, and harvesting costs of rose and marigold farming may vary due to differences in the production system and the effect of seasonal demand.

### 2.2.4 Ethical standard

The ethical standard was maintained during the research and it was approved by the Research Management Committee (RMC) of Bangabandhu Sheikh Mujibur Rahman Agricultural University. Before each interview, the research purpose and the confidentiality of the data were described to each farmer, and then their verbal consent to provide information voluntarily was taken. The questionnaire content and procedure were properly reviewed by the research team.

## 3. Results and discussion

### 3.1 Descriptive statistics of socio-demographic characteristics

Credit unconstrained farmers are those who can run their farms without any credit or if they are getting the necessary credit. On the other hand, credit-constrained farmers are those who have not received their demanded credit or do not have access to alternative sources of credit (Dong et al., 2012; Feder et al., 1990; Guirking & Boucher, 2008). Table 1 demonstrates the descriptive statistics of the socio-demographic characteristics of rose and marigold farmers. The findings indicate that marigold growers are more credit-constrained than rose growers. Marigold farmers have smaller farms than rose producers. This smaller farm may increase the possibility of a credit-constrained situation. On the other side, rose farmers can use their comparatively larger farmland as collateral to obtain the required loan, which makes their credit unconstrained (Mitra et al., 2019). Additionally, 55% of marigold growers farmed on self-owned land, while 75% of rose farmers farmed on their own farms. Thus, 45% of marigold growers farmed in rented inland and those farmers cannot use their own land as collateral for receiving financing. On the other side, rose farmers can utilise their own land as collateral. The average family size of rose farmers is 5.80, slightly higher than the national average family size (Prodhan & Khan, 2018). The experience of rose growers is greater than that of marigold growers, which may aid in their understanding of the credit application and processing procedures that enable them to have access to credit without restriction. Mitra et al. (2019) and Rusiana et al. found a similar result in the case of agriculture farming. Marigold farmers have more off-farm income compared to their counterparts.

The result's most likely explanation is that, due to their higher profitability from rose farming, they are considerably less active in other off-farm businesses. On the other side, marigold farmers are comparatively less focused on their farming because of their lower profitability. Moreover, Nehring and

**Table 1.** Descriptive statistics of socio-demographic characteristics of flower farmers.

Socio-demographic characteristics	Rose		Marigold	
	Mean	Standard Deviation	Mean	Standard Deviation
Credit constraint (Constraint =1, Unconstraint = 0) (Percentage of constraint farmer)	0.24	0.43	0.61	0.49
Age (in years)	41.77	13.50	37.59	11.96
Education (years of schooling)	7.41	4.83	7.52	4.62
Marital status (Single =1, Married =0) (Percentage of single member)	0.16	0.48	0.26	0.45
Family member	5.68	2.41	4.80	1.23
Male member	2.77	1.20	2.39	0.93
Female member	2.84	1.56	2.35	1.04
Earning member	1.70	0.82	1.55	0.71
Experience (in years)	18.12	8.98	14.00	7.80
Training (in days)	1.29	3.60	2.32	5.21
Farm size (in decimal)	67.12	54	51.56	47
Land tenure (owned = 1, cash tenant = 0) (Percentage of owner operated farm)	0.75	0.44	0.55	0.50
Source of seed (own = 1, buy = 0) (Percentage of own supplied seed)	0.69	0.46	0.70	0.46
Off-farm income (Yes = 1, No = 0) (Percentage of positive response)	0.25	0.44	0.50	0.50

**Table 2.** Technical efficiency and technological gap ratio across farms and groups.

Flowers	Credit-constrained and unconstrained situation of flower farms	Mean managerial efficiency (MME)	Meta technical efficiency (MTE)	Technological gap ratio (TGR)
Marigold	Credit constrained farms	0.77	0.64	0.64
	Credit unconstrained farms	0.97	0.73	0.96
Rose	Credit constrained farms	0.81	0.74	0.91
	Credit unconstrained farms	0.83	0.77	0.92

Fernandez-Cornejo (2005) found that the scale and technical efficiency of farming operations are increased by off-farm revenue.

### 3.2 Technical efficiency of credit constraint and unconstraint farmers

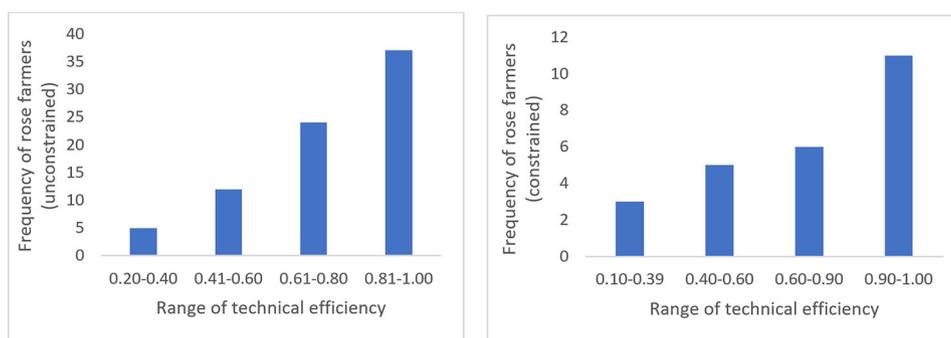
Credit is an important determinant for the commercialization of flower production. If flower growers can run their operations without any sort of credit or if they are getting the necessary credit, they are said to have no credit constraints. On the other hand, if farmers are not provided with enough credit or do not have access to alternative sources of credit, they are considered to be credit-constrained (Dong et al., 2012; Feder et al., 1990; Guirkingner & Boucher, 2008). Credit-constrained farmers find it very complicated to use the optimal amount of inputs and produce more flowers. Table 2 demonstrates the TE and TGR of rose and marigold farmers in Bangladesh.

The Marigold farmers obtain the highest mean managerial efficiency score (97%) when he is not constrained. It indicates that output could be increased by 3% without increasing input at the regional level. Under a credit-constrained situation, the mean managerial efficiency is 0.77, which implies that there is room to improve efficiency by 23% if compared to the regional (group) frontier. The same is true for growers of roses, however, growers who have no credit constraints have slightly higher efficiency than growers who have credit constraints. Overall, the regional production of flowers can be improved if all farms can get the necessary credit facilities.

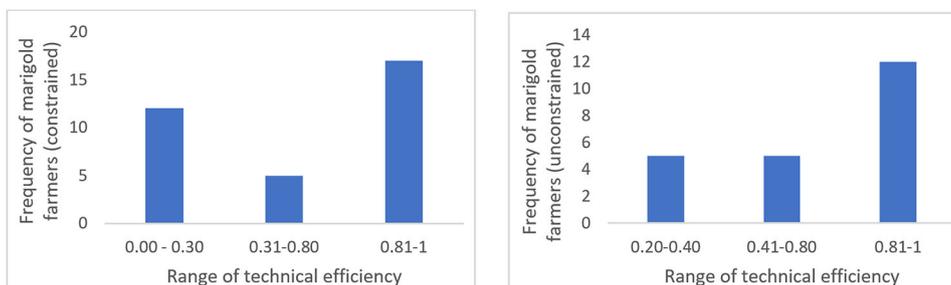
To find out how different constrained and unconstrained farmers are in terms of their mean technical efficiency compared to the best practice frontier, meta-technical efficiency scores (MTE) are used. Table 2 shows that the mean meta-technical efficiency for Marigold farmers is highest when unconstrained (0.73) and lowest when credit is constrained (0.64) relative to the meta-frontier, which indicates output could be increased by 27% and 36%, respectively, without increasing input. On the other side, the efficiency of credit-unconstrained rose farmers is slightly higher than that of constrained rose farmers. Generally, due to credit constraints flower farmers are unable to use the optimal level of inputs, which severely affects the productivity and efficiency of flower farms (Mitra et al., 2019; Zylberberg, 2013). Mitra et al. (2022) found that the meta-technical efficiency of flower farmers was the highest in normal time and the lowest during the COVID-19 pandemic due to the growing input price, reduced input availability, and a less than optimal amount of inputs.

Additionally, the meta-technical efficiency of rose farmers is higher than that of marigold farmers. The most probable explanation of the result is that the profitability of rose farmers is higher than marigolds in the study area. Moreover, farmers tend to cultivate more roses, and their average farm size is also significantly greater. Higher farm size and profitability may encourage financial institutions to extend favourable credit terms to the rose farmers. On the other hand, marigold farmers have lower farm sizes and profitability; these situations discourage financial institutions from extending sufficient credit facilities to marigold farmers. In addition, the off-farm income of marigold farmers is higher than that of rose farmers, which indicates the focus of marigold farmers is slightly diverted from marigold farming, which leads to inefficiency in farming.

Table 2 shows the mean technological gap ratio of flower farms in two different scenarios, including a credit constraint situation and an unconstrained situation. When given sufficient credit, the marigold farm has the greatest TGR scores (0.96), which means that the farmers could generate 4% more output with the same inputs and technology compared to the meta-frontier. In addition, Marigold achieves the lowest TGR (0.64) when they are credit-constrained. In this case, farmers have the room to produce 36%



**Figure 3.** Technical efficiency of credit constrained and unconstrained rose farmers.



**Figure 4.** Technical efficiency of credit-constrained and unconstrained marigold farmers.

more output using the same inputs and technology relative to the meta-frontier. The result indicates that the scope of increasing productivity when the farm is credit-unconstrained is considerably higher than that of being constrained. In the case of rose farms, the difference in TGR between credit-constrained and non-constrained farmers is very little. The most likely explanation of the result is that rose farmers typically experience a healthy return on investment despite the high cost of inputs, which encourages them to embrace cutting-edge technologies. Mitra et al. (2022) found that the technology gap ratio expanded during COVID-19, which suggests farmers could produce more by using the same level of inputs.

Figure 3 demonstrates that, on average, unconstrained rose farmers tend to have higher levels of technical efficiency compared to credit-constrained farmers. Nevertheless, few credit-constrained farmers have higher levels of technical efficiency, while few unconstrained farmers have lower levels of technical efficiency. In both cases, the technical efficiency score distribution of rose farmers is concentrated towards the right side of the upper half, with the majority of farms having scores between 0.60 and 1.00.

Figure 4 shows the variation in the technical efficiency of credit-constrained and unconstrained marigold farmers. A large proportion of credit-constrained farmers have technical efficiency scores between

**Table 3.** Factors affecting flower farmers' efficiency.

Efficiency	Tobit regression	
	Coefficient	Standard error
Constant	0.570	0.187
Training (in days)	0.007	0.008
Source of seed (If own = 1, buy = 0)	0.168*	0.101
Land tenure system (owned = 1, cash tenant = 0)	0.156***	0.572
Farm area (ln decimal)	0.001	0.148
Earning family member (in number)	-0.124***	0.034
Education (in years of schooling)	0.004	0.004
Age (in years)	0.001	0.001
Off farm income (If yes = 1, otherwise = 0)	-0.358*	0.193
Credit Constrained (If constrained = 1, unconstrained = 0)	-0.143***	0.047
Types of flower (If marigold = 1, rose = 0)	-0.160***	0.074
Wald chi2(10)	75.55	
Prob > chi2	0.000	

Significance level: \*\*\* for 1%, \*\* for 5% and \* for 10%.

0–30% and 81–100%. On the other hand, when farmers are credit-unconstrained, most of the farmers have technical efficiency scores in the range of 81–100%. The figure demonstrates that credit-constrained marigold farmers tend to have lower levels of technical efficiency compared to unconstrained farmers. However, there is still considerable variation in efficiency scores within both groups, with some farmers performing very well and others performing poorly.

### 3.3 Determinants of flower farmers' efficiency

As shown in Table 3, sociodemographic factors can influence the meta-technical efficiency of flower farmers. The Wald test ensures the overall significance of all the independent variables of the model except for those that are constant. The results indicate that sociodemographic factors such as source of seed, and land tenure have a significant positive impact, while types of flowers, earning family members, off farm income, and credit constraints have a significant negative effect on the technical efficiency of flower farmers.

The coefficient of earning family members demonstrates the negative effect of having more earning members on the efficiency of flower farmers, indicating that the meta-efficiency scores of flower farmers decrease as the number of earning members increases. An increased number of earning members may reduce the availability of family labor employed in the farm that make it critical to manage the farm properly which causes a decline in technical efficiency of flower farmers. Mitra and Yunus (2018) and Kaysar et al. (2024) found an opposite result.

Moreover, the coefficient of the source of seed shows a positive effect on the technical efficiency of flower farmers. That means if flower farmers can own their seedling source, then it will increase their meta-efficiency scores. When a flower farmer produces their seedlings, it doesn't need to incur extra costs, which works as a contributing factor in increasing the technical efficiency of flower farmers. Haque et al. found in their study that sources of seed have a positive impact on rose cultivation. The unavailability of High Yielding Variety (HYV) seedlings negatively affects rose farmers. Therefore, it's crucial to create superior-quality flowers using agro-technologies and breeding techniques, then distribute them to farmers (Kant et al., 2023).

The land tenure system is positively related to farmers' efficiency, which implies that the meta-efficiency scores of flower farmers increase when farmers own the farmland. Landowners can use it as collateral, which is imperative for receiving credit from different financial institutions. On the other hand, cash tenant farmers have to pay a yearly rent to the land owners, which puts huge mental pressure on them. As tenant farmers have to spend more cash on fixed assets, spending on variable-cost items might be affected badly, which leads to inefficient flower production. For this reason, the flower farmers who own land in our study area are efficient in their production. Mitra et al. (2021) and Mitra et al. (2023) found the opposite result. Whereas Paltasingh et al. (2022) found that secured land ownership considerably increases farm efficiency. However, efficiency is unaffected by the kind of rental agreement, whether it is fixed-rent or sharecropping.

The negative coefficient of off-farm income indicates that off-farm income has a negative effect on the efficiency of rose cultivators, so the greater the off-farm income, the lower the meta-efficiency scores. The likely explanation for the result is that rose cultivators in the study areas are mostly involved in different businesses and jobs. When they can earn a sufficient income from off-farm sources, their focus may be shifted from farming and they may lose interest in the adoption of modern scientific farming practices. Additionally, they may find it difficult to manage time for attending any training program which may cause a reduction in meta-efficiency scores.

The coefficient of the credit-constrained farmer shows a negative effect on the efficiency of flower farmers, which means the meta-technical efficiency scores of flower farmers decrease when the farmers are credit-constrained. Furthermore, in the case of rice, when access to credit enhances yield, Jimi et al. (2019) observe a similar kind of consequence.

The negative coefficient of types of flowers indicates that rose farmers are more efficient than marigold farmers. The most probable explanation of the result is that higher profitability and a larger average farm size may be the reasons behind the higher level of efficiency. Higher profitability and larger

**Table 4.** Profitability differences of marigold farmers depending on the credit-constrained situation.

	Marigold		Differences
	Credit constrained	Credit unconstrained	
	Fixed cost		
Garden Scissor	123	155	31.67
Sprayer	415	380	-35.04
Bucket	248	651	403.42
Other			
Land Use Cost (LUC)	112,332	112,332	56041.94
Total Fixed Cost (TFC)	113,017	113,427	2382371.61
	Variable cost		
Harvesting	8735	11,790	3054.73
Power Tiller	17,596	18,893	1296.95
Seeding	22,185	22,909	723.85
Irrigation	1281	1306	25.72
Temporary	62,431	86,782	24351.29
Fertilizer	59,771	69,520	9748.81
Insecticide	50,932	63,329	12396.80
Fencing material	4544	5649	1104.70
bamboo	4288	3086	-1202.43
Sutli	3289	3023	-266.63
Interest on Operating Capital (IOC)	21,998	26,529	4530.57
Total Variable Cost (TVC)	257,051	321,292	64241.08
Total Cost (TC)	257,837	434,719	64651.10
Total Return	582,342	785,991	203648.70
Gross Margin	202,903	351,272	148369
BCR	1.55	1.68	0.12

farm sizes help to lessen the credit constraint problem, which may help to improve the efficiency level of rose farmers. Mitra et al. (2019), Gollin (2018), and Islam et al. (2023) found a consistent result.

### 3.4 Profitability differences of flowers depending on credit constraint and unconstraint farmers

#### 3.4.1 Marigold

Among the respondents in the study areas, about 37% of flower farmers are involved in marigold farming, while the rest (63% of flower farmers) are engaged in rose farming. Growing marigolds in Bangladesh is a lucrative business. The net return of marigold farmers was 81% higher than for lentils, 85% higher than for mustard, and 6% lower than for potatoes. Flower farmers are classified into two groups depending on their credit accessibility from different financial institutions, i.e., credit-constrained and un-constrained. Farmers' profitability changed significantly depending on the constrained situation of the marigold farmers.

Table 4 presents a comparative cost-benefit analysis of marigold farmers depending on credit-constrained and unconstrained situations. The fixed-cost items listed are garden scissors, sprayers, buckets, and land use costs. Credit-constrained farmers have lower fixed costs than their unconstrained counterparts. Due to the credit constraint situation, flower farmers cannot afford the increasing cost of those instruments because these items are expensive. Guirkingner and Boucher (2008) also found similar results for Peruvian agriculture, as credit-constrained farmers have lower productivity.

Moving on to variable costs, it is worth noting that credit-unconstrained farmers spend significantly more on all variable cost items compared to credit-constrained farmers. Particularly, fertilizer and insecticide costs are almost 15–25% higher for credit-unconstrained farmers, indicating that they are using more of these inputs to increase yields or protect their flowers from pest and insect attack. Porgo et al. found a similar result for labor use. The probability of using hired labor on an agricultural farm is reduced if the farm is credit-constrained, and the constraint situation can distort labor allocation decisions in farming households. Additionally, credit-unconstrained farmers spend more on harvesting, with a difference of 3054.73 taka compared to credit-constrained farmers.

As credit-constrained farmers have inadequate financial facilities, they face many difficulties in purchasing and applying inputs on time. Therefore, farmers who receive their demanded credit can apply different modern inputs (i.e., fertilizer, insecticides, and power tiller) in an appropriate and timely manner. Credit-constraint farmers are mostly depending on different traditional inputs (i.e., labor, seedlings)

**Table 5.** Profitability differences of rose farmers depending on the credit-constrained situation.

	Credit constrained	Credit unconstrained	Differences
	Fixed cost		
Garden Scissor	302	473	170
Sprayer	441	364	-77
Bucket	61	229	167
Other			0
Land Use Cost (LUC)	112,332	112,332	0
Total Fixed Cost (TFC)	113,136	113,397	261.39
	Variable cost		
Harvesting	681,548	1,431,714	750166.04
Power Tiller	18,939	25,982	7042.55
Seeding	38,342	31,416	-6925.96
Permanent labor	47,667	25,972	-21694.70
Temporary	329,009	377,295	48285.95
Fertilizer	236,698	201,454	-35244.06
Insecticide	212,999	192,188	-20810.98
Fencing material	9989	7561	-2427.87
Bamboo	8637	5069	-3567.74
Sutli	5099	3050	-2048.59
Irrigation	61,722	61,939	217.39
Subtotal	1,650,648	2,363,640	712992.05
Interest on Operating Capital (IOC)	145,108	212,728	67620.04
Total Variable Cost (TVC)	1795756	2,576,368	780612.09
Total Cost (TC)	1,908,892	2,689,766	780873.48
Total Return	3208541.82	5,032,284	1823741.73
Gross Margin	1,299,650	2,352,073	1052422.82
BCR	1.68	1.97	0.29

(Mitra et al., 2019). Lack of knowledge of modern production technologies was the main barrier for most marigold growers (Singh & Singh, 2022). Additionally, the productivity of credit-unconstrained farmers is significantly higher than that of credit-constrained farmers (Guirkinger & Boucher, 2008; Mitra et al., 2019).

Constrained farmers have a lower gross margin and benefit-cost ratio (BCR) than that of credit-unconstrained farmers. However, it is important to note that both groups have a BCR greater than 1, indicating that they profit from flower production and that it is a viable economic activity. The average BCR for unconstrained farmers is 1.68 in comparison with that of constrained farmers, which is 1.55. This indicates that available credit facilities have an enormous effect on gross margins and benefits. Due to the credit constraint situation, input use, production, and profitability of flowers have sharply decreased. In addition, this situation further exacerbates itself because of the price hike of inputs during the COVID-19 pandemic and the Ukraine-Russia war (Gliessman, 2021).

### 3.4.2 Rose

Insufficient credit facilities, a lack of proper credit access, and the high interest rates of local financial institutions are also critical problems for rose farmers (Hasan et al., 2019; Singh & Singh, 2022). Table 5 demonstrates the profitability differences of rose farming depending on the credit-constrained situation. When considering the fixed costs, credit-constrained rose farmers have lower expenditures on garden scissors and buckets compared to their unconstrained counterparts. This discrepancy can be attributed to the limited access to credit faced by constrained farmers.

Variable costs play a crucial role in determining the financial outlay for rose farming. Credit-unconstrained farmers spend more financial resources on purchasing variable inputs such as seedlings, fertilizer, insecticides, harvesting, and irrigation compared to their constrained counterparts. Hasan et al. (2019) found that higher prices of inputs hurt the rose farmers severely. Among different variable inputs, credit-unconstrained farmers incurred significantly higher costs for harvesting, highlighting the advantage of access to credit. This discrepancy can be attributed to their greater access to credit and optimum utilization of inputs to enhance yields. Moreover, rose plant labor costs are higher due to excessive thrones, requiring more time for fertilizer application, pruning, and weeding, as labor must work on knees and move slowly (Mitra et al., 2022).

Furthermore, the gross margin and benefit-cost ratio (BCR) figures shed light on the overall profitability of rose farming for the two groups. The result demonstrates that credit-unconstrained rose farmers have higher profitability compared to constrained farmers. BCR and gross margin indicate that credit-

unconstrained farmers generate higher profitability per unit of investment. The probable explanation of the result is that credit constrained situation impedes the ability of farmers to invest in critical inputs, ultimately affecting their production and profit margins. On the other hand, credit-unconstrained farmers benefit from a higher level of investment, enabling them to use optimal levels of inputs to achieve greater yields and profitability. Blancard et al. (2006) also found similar results for French farmers.

#### 4. Conclusion and policy implications

This study investigates the effects of credit-constrained situations on the technical efficiency and profitability of flower farmers, taking Bangladesh as an example. Thirty-seven percent of flower farmers received the drawback of a credit-constrained situation, while the rest, sixty-three percent, received the benefit of credit-unconstrained situation. The mean meta-technical efficiency for Marigold farmers is highest when unconstrained (0.73) and lowest when credit is constrained (0.64) relative to the meta-frontier, which indicates output could be increased by 27 and 36%, respectively, without increasing input. On the other side, the efficiency of credit-unconstrained rose farmers is slightly higher than that of constrained rose farmers. In addition, credit-constrained marigold farmers achieve the lowest TGR (0.64) compared to credit-unconstrained farmers. In this case, farmers have the room to produce 36% more output using the same inputs and technology relative to the meta-frontier. Land tenure system, age, and education have a significant positive impact on the meta-technical efficiency of marigold farmers. Additionally, family members, source of seed, and experience have a significant positive impact on technical efficiency, while off-farm activities have a significant negative effect on the meta-technical efficiency of rose farmers. The profitability of credit-unconstrained marigold and rose farmers is higher than that of credit-constrained farmers.

Credit accessibility for flower farmers at a lower interest rate should be ensured to remove the credit-constrained situation, which assists in ensuring efficient and profitable flower production. Additionally, it will facilitate the adoption of modern agricultural practices, which helps reduce the technological gap. Documentation problems regarding credit facilities tried to be reduced to ensure sufficient credit access for flower farmers. To increase the financial inclusion of flower farmers, the credit application process, preconditions for receiving credit, and credit repayment plan should be relaxed and friendly for the flower farmers. Although educational facilities have developed in recent decades in Bangladesh, further effort should be needed to encourage the farmers to receive higher education. Educated farmers can adopt modern technology, which may reduce the technological gap and increase the efficiency and profitability of flower farmers. In addition, aged and experienced farmers should be encouraged in flower farming, as they are more efficient in farming. Besides, the owner-operated farm should cultivate the land himself instead of giving the land as rent to increase efficiency. As their involvement in off-farm income-generating sources has reduced the technical efficiency of rose farmers, they should focus on only rose farming. Moreover, farmers should use locally produced, high-quality seedlings, which reduce their production costs and increase efficiency. Although the findings of the study can be generalized in developing countries, they may not be generalized in developed countries due to differences in cultivation processes, inputs used in production processes and socio-demographic characteristics. Future studies will be carried out to identify the risk factors involved in farming and the willingness to pay an insurance premium to reduce the risk involved in flower farming.

#### Authors' Contributions

Sandip Mitra: Prepare draft paper, Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data, Supervision. Md. Rashid Asef Dipto: Data collection and entry, Analyzed and interpreted the data, Writing draft paper. Yasin Ibrahim Ankon: Writing draft paper.

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The authors declare that they have no known competing interests.

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## Data availability statement

I agree to make data and materials supporting the results or analyses presented in the paper available upon reasonable request.

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