Research Article

The Impact of Credit Effectiveness on Enhancing Technical Efficiency and Productivity of Sugarcane Farming in West Java Province, Indonesia

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Abstract | One of the factors that determines farmers' readiness in managing production inputs efficiently is capitalization. The plantation sub-sector crops, particularly sugarcane, saw a 7.8% increase in People's Business Credit (KUR) realized between 2019 and 2023. The purpose of this study is to examine how improving technical efficiency and productivity is impacted by credit effectiveness. About 257 sugarcane farmers responded, all of whom received assistance from PT PG Jatitujuh Majalengka Regency in West Java Province. According to the findings, out of the 257 respondents, a total of 40 sugarcane growers received credit that was disbursed on time and in the correct amount, indicating effective credit utilization and in contrast, 217 farmers received credit that was disbursed neither on time nor in the appropriate amount, thus categorized as ineffective credit. Stochastic frontier analysis results indicated that cultivated land, age, education, number of seeds, amount of fertilizer, quantity of herbicide, and amount of labor utilized for sugarcane farming were the elements that affect sugarcane productivity. The average technical efficiency for farmers whose credit is effective is 0.9165 and those whose credit is ineffective have an average technical efficiency of 0.8738. The amount of family dependents, farmer education and credit effectiveness all have an impact on how inefficient sugarcane cultivation is. The results of Propensity Score Matching demonstrate that improving the technical efficiency and production of sugarcane cultivation is positively and significantly impacted by credit effectiveness.

Received | Jun 25 2025; **Accepted** | Aug 15, 2025; Published | November 05, 2025
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Citation | Dwirayani, D., N. Nuryartono, D. Rachmina and A. Rifin. 2025. The impact of credit effectiveness on enhancing technical efficiency and productivity of sugarcane farming in west java province, Indonesia. Sarhad Jurnal of Agriculture, 41(4): 1824-1836.
DOI | https://dx.doi.org/10.17582/journal.sja/2025/41.4.1824.1836
Keywords | Credit effectiveness, People's business credit, Sugarcane farming, Technical efficiency, Productivity.

Introduction

In 2020, the plantation subsector had the highest absorption of People's Business Credit (KUR), reaching approximately 89.19% or around IDR 18.16 trillion, involving 463,572 debtors. In 2021, the realization of plantation KUR saw a significant increase to IDR 29.74 trillion or about 38.8%. This figure indicates that there is an increase in farmers' need for capital assistance. Sugarcane is one of the leading plantation commodities that plays a strategic role in Indonesia's economy and requires substantial capital. Sugarcane cultivation is carried out by smallholder farmers, private companies, and state-owned enterprises (SOEs). Both private companies and SOEs are granted the right to cultivate land under the Right to Cultivation (HGU) agreement. In its implementation, SOEs engage in partnerships or collaborative arrangements with farmers.

The trend in the amount of loans received by farmers managing HGU (Right to Cultivation) land from 2018 to 2022 showed an average annual increase of 11.04%. During the same period, the number of borrowing farmers (debtors) also increased. Ideally, the increase in sugarcane farming credit should be followed by a corresponding rise in productivity. However, data from 2018 to 2022 indicate that productivity grew at a slower rate (6.4%) compared to the increase in cultivated area (23.6%) and total production (36.02%). This raises the question of whether the credit received has been properly utilized for farming activities. Is the slow productivity growth a result of inefficient use of production inputs in sugarcane farming? Efficient input utilization in farming is influenced, among other factors, by the availability of capital.

Adequate capital allows farmers to use and combine production inputs more optimally (Wijaya *et al*., 2023). Easy access to credit can improve the technical efficiency of farming (Permadhi and Dianpratiwi, 2021). The ability of farmers to maximize production output by making the best use of production inputs is the concept of efficiency. Credit allows producers to more effectively distribute elements of production and obtain agricultural inputs in a timely manner. The aforementioned explanation leads one to the conclusion that capital expenditure plays a crucial role in enhancing technical efficiency, which is anticipated to result in higher output.

According to earslier studies, the majority of academics looked at how farmers who use loans instead of cash have an impact on improving technical efficiency and productivity. Capital loans or credit have been shown to enhance technical efficiency (Rabbany *et al*., 2022; Taubadel and Saldias, 2014; Mengui *et al*., 2019; Missiame *et al*., 2021; Matsvai *et al*., 2022; Martey, 2019). Access to agricultural credit is also positively associated with productivity (Assouto and Houngbeme, 2023; Wongnaa *et al*., 2023). However, some studies present different findings, indicating that credit access does not necessarily improve technical efficiency or productivity (Nakano and Magezi, 2020; Zozimo *et al*., 2023). These conflicting results suggest that the relationship between credit, technical efficiency, and productivity remains inconclusive.

Most previous studies have focused on comparing farmers who have access to credit and those who do not, as well as the amount of credit received, in relation to technical efficiency and productivity. This study attempts to address these limitations by considering credit effectiveness. Farmers who receive credit but fail to experience improvements in technical efficiency and productivity may not be utilizing their credit properly or the credit may not be effective. Credit is considered effective if it is used on time and in the appropriate amount according to the needs of the farming activity. Measuring credit effectiveness is thus essential in analyzing its impact on technical efficiency and productivity.

Meterials and Methods

The research was conducted in Jatitujuh Subdistrict, Majalengka Regency, West Java. The sampling frame consisted of all partner sugarcane farmers cultivating HGU Right to Cultivation (HGU) land managed by PG Jatitujuh during the 2022/2023 planting season who received credit. A total of 257 farmers were purposively selected from three villages that serve as the largest supporting areas for PG Jatitujuh's HGU land in Jatitujuh Subdistrict, namely Sumber Kulon Village, Sumber Wetan Village, and Jatiraga Village. Primary data were collected through structured interviews with farmers using a questionnaire as the main instrument. In addition, key informant interviews were conducted with stakeholders such as farmer group leaders, association heads (Gapoktan), prominent farmers, agricultural extension workers, bank officials, representatives from PG Jatitujuh unit, and other relevant informants needed to complement the research data. The credit effectiveness analysis was conducted using quantitative descriptive methods. Technical efficiency was analyzed using Stochastic Frontier version 4.1, while the impact of credit effectiveness was measured using the Propensity Score Matching (PSM) method.

Credit effectiveness measurement

Credit effectiveness was measured using two indicators: timeliness and adequacy of credit. This approach aligns with previous studies (Mudassir *et al*., 2020; Syamsudin *et al*., 2022). Seven components were financed through credit: land use compensation (KPL), seeds, fertilizers, herbicides, land preparation, mechanization, and harvesting–transportation (TMA). While KPL, land preparation, mechanization, and TMA were provided in cash, seeds, fertilizers, and herbicides were distributed in kind.

The credit effectiveness score was calculated by averaging the scores of timely credit and adequate amount of credit. Timeliness was assessed by comparing the timing of credit disbursement with the actual use of inputs based on Good Agricultural Practices (GAP). A positive time gap indicated timely credit, while a negative gap indicated delayed availability; scores of ≥100% were considered timely. Adequacy was determined by comparing the actual credit received with the required input quantities or credit ceiling. Farmers with a combined credit effectiveness score ≥100% were categorized as having effective credit, and those below 100% as having ineffective credit.

Stochastic frontier

The Stochastic Frontier Analysis (SFA) method is a quantitative technique used to measure technical efficiency. SFA is a parametric measurement technique that gauges production efficiency and estimates the production frontier. The frontier function describes the maximum production generated for a given amount of production input sacrificed. A production function is used in the Stochastic Frontier Analysis (SFA) technique, where production input factors, errors, and production inefficiencies determine output or production. A normal distribution is assumed for statistical noise in SFA, with half normal being the most frequently assumed distribution. The two procedures used in the maximum likelihood estimation approach are MLE and OLS testing for heterokedasticity, autocorrelation, and multicollinearity. The following is a description of the stochastic frontier function equation used in this study :

$$Y=\beta_0+\beta_1 LnX_{1t}+\beta_2 LnX_{2t}+\beta_3 LnX_{3t}+\beta_4 LnX_{4t}+\beta_5 LnX_{(5t)})+ (vti- uit)$$

Where

Y = sugarcane production or output produced (ku/ha)

X_1 = land area (ha)

X_2 = number of seeds used (qu)

X_3 = amount of fertilizer used (qu)

X_4 = amount of herbicide used (liters)

X_5 = total labor (HOK)

X_6 = Plant category (PC=1, RC=0)

β = constant

vit-uit= Random variables that are assumed to affect the level of inefficiency technical.

The calculation of the level of efficiency and technical inefficiency is a calculation to assess a business unit's ability to produce maximum output from the use of certain production inputs. Technical efficiency can be measured using the following formula (Coelli *et al*., 2005)

$$TE = \frac{Yi}{Y*} = \frac{Yi}{expexp(xi\beta)} = \frac{expexp\ (xi\beta+Vi-Ui)}{expexp(xi\beta+Vi)}$$

Where

= exp exp (-) i = 1, 2, 3, ... n

TE = Technical Efficiency

yi = actual output of the observation

y* = estimated output frontier obtained from stochastic frontier production

Only functions with a specific amount of input and output can use the technical efficiency value, which runs from 0 to 1. It reverses the effect of the technical inefficiency value. If a farmer's Technical Efficiency (TE) score is more than 0,7, they are deemed technically efficient. The inefficiency impact is expressed as an explicit function of a vector of production inputs in a random error, according to the model equation for estimating the factors or impacts of technical inefficiency that are expected to affect the level of technical efficiency and to determine the value of the distribution parameter (ui) (Kumbhakar *et al*., 2015). The impact of technical inefficiency is stated as follows:

$$\mathbf{uit= zitd + wit}$$

$$-ui = \delta_0+ \delta 1Z_1 + \delta 2Z_2 + \ldots\ \delta_5\ Z_7 + D_{(1)}$$

where

ui = technical inefficiency

δ_0 = constant
Zi = farmer age (years)
Z_2 = Farmer education (years)
Z_3 = Farming Experience (years)
Z_4 = number of family dependents (people)
Z_5 = Financing pattern (HGU Avalis=1, HGU Mandiri=0)
Z_6= Credit effectiveness

Propensity score matching (PSM)

Propensity Score Matching (PSM) is a social research statistical analysis used to analyze observational data to reduce bias that may occur due to differences between compared groups. The PSM method was first introduced by (Rosenbaum and Rubin, 1983) and developed by (Heckman *et al.*, 1998) .The rationale for using propensity scores to evaluate impact is to reduce selection bias, as observational studies always have problems concluding due to potential confounders.

Some of the steps taken in PSM, according to (Farida *et al.*, 2016), are as follows: first, the observation group is divided into treatment and control groups. In this research, treatment and control groups consist of groups of farmers effective credit and those with ineffective credit. The first step is to determine the model to be estimated using logit regression analysis. The model used in the research is

$$g(x) = \ln\left(\frac{\pi(x)}{1-\pi(x)}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k = x^T\beta$$

The next step is to identify the groups that will be part of the treatment and control groups after deciding the variables to estimate in the logit regression model. The division of groups in this research is for the treatment group consisted of farmers utilizing HGU and independent PG land who had effective credit, indicated by a credit effectiveness score equal to or greater than 100% and the control group is HGU avalis and independent farmers who have ineffective credit with a credit effective score below 100%. The outcomes that will be seen are technical efficiency, productivity and sustainability of sugarcane farming. Determining the matching algorithm is the next step in PSM; the different matching techniques are as follows: The Average Treatment Impact on the Treated (ATT) can be determined via Nearest Neighbor Matching (NNM), by caliper match and kernel match, or by stratification. The next step is to compare the distribution of the treatment group and the control group in order to find areas of overlap and shared support. The following is a description of the variable equation whose effects will be examined:

$$Yi = \beta 0 + \beta ixi + \mu$$

Where:
Yi = Outcomes to be assessed for their impact
β0 = Constant/Intercept
β1, n = Regression Coefficient
x 1, n = Independent Variable
μ = Error Term

The average difference between the treatment group and the control group is used to determine the outcome variable's difference. The influence of the treatment is shown in the difference (Rosenbaum and Rubin 1984).

Table 1: *Description of logit regression variables*

Variables	Variable Type	Description
g(x)	binary	Effective credit = 1, Ineffective credit = 0
Characteristics of sugarcane farmer (X)		
Age (X_1)	continuous	age of sugarcane farmers
Education (X_2)	continuous	Elementary = 1, junior high = 2, high school = 3, college = 4
Experience(X_3)	continuous	Period time on growing sugarcane (years)
Number of family dependents (X_4)	continuous	Number of families covered
Land area (X_5)	continuous	Sugarcane planted area
Side job (X_6)	continuous	Present = 1, not present = 0
Savings ownership (X_7)	binary	Have savings = 1, do not have = 0
Other sources of loan (X_8)	binary	Have = 1, do not have = 0

$$\Delta i = Y\,1 - Y\,0$$

Δi = Impact of treatment on individual i (i = 1,2,3...,N)
Y1 and Y0 = Potential farm yields with effective credit and ineffective credit.

$$AT = (\Delta) = (\;1|\;,YXD = 1) - (\;0|\;,YXD = 1)$$

Average treatment (AT) cannot be used on cross-sectional data because it will cause bias. The AT model is appropriate for time series where there is data before and after treatment. Meanwhile, a suitable equation model used for cross-section data is ATT, which is a modification of AT.

$$ATT = (\Delta|D = 1) = (Y\,1|\;, = 1) - (Y\,0|\;,XD = 0)$$

The equation for the Average Treatment Effect on the Treated (ATT) is used to determine the potential output if farmers were to adopt the treatment, represented by a dummy variable. This is the selection bias of the equation because (0|EYXD, = 1) is unobservable. This observation bias scenario gives rise to self-reflection bias. The bias can be formulated as follows:

$$Bias = (\;1|\;,YXD = 1) - (\;0|\;,YXD = 0)$$

Bias is the difference between the impact of the sample receiving the treatment (effective credit) and the difference between the impact of farmers not receiving the treatment (ATT) (ineffective credit). Maximum likelihood estimation is used to estimate the equation. As a result, there is bias in the PSM estimate of ATT selection. The results of treatment group and control group observations are compared following propensity score matching. The formula for PSM estimation is as follows: (Rosenbaum and Rubin, 1983).

$$ATT = (\Delta|(X\;),D = 1) = (\;1|EYPX\;)\;(,D = 1) - E\;(\;0|\;(YPX\;),D = 0)$$

Results and Discussion

Effectiveness credit

The credit effectiveness score for each respondent was calculated by combining the percentage scores of accuracy for seven credit-financed components, assessed through two indicators timeliness and adequacy of amount and then averaging the two. The resulting credit effectiveness scores ranged from 87.3% to above 106.1%, with an average score of 94%. In this study, farmers were categorized into two groups: those with effective credit and those with ineffective credit. Farmers were classified as having effective credit if their credit effectiveness score was equal to or greater than 100%, while those with scores below 100% were considered to have ineffective credit. The results indicate that 217 farmers (84.4%) fell into the ineffective credit category, while only 40 farmers (15.6%) had effective credit.

Factors affecting sugarcane production

The Maximum Likelihood Estimation (MLE) and Ordinary Least Square (OLS) approaches are used to estimate parameters in regression. To check for a breach of the classical assumptions, the OLS method is used. To meet the requirements of the BLUE (Best Linear Unbiased Estimator) criteria, the parameter estimate must satisfy four traditional assumptions: the autocorrelation, multicollinearity, heteroscedasticity, and normality tests. (Firdaus, 2021) states that a regression function with the OLS method can be trusted in the truth of its model estimation if the classical assumptions underlying the model are met; otherwise, if they are not met, the estimation of the regression model can be doubted.

This study examines the factors that affect sugarcane output, such as land area, seeds, fertilizer, herbicides, labor and plan category. The factors influencing sugarcane production can be identified from the data analysis findings using Fontier 4.1 software. Table 2 displays the findings of the data analysis. The output of sugarcane is positively and significantly impacted by the production elements of land area, seeds, fertilizer, herbicides, and labor. The production of sugarcane is positively and significantly affected by land area. This implies that it should be possible to boost sugarcane production as the amount of arable land increases. The coefficient of elasticity of the land area input, which is 0,46. An increase in land area of 1% will result in a 0,46% rise in production. The study's findings support those of studies by (Januarisky, 2025), which found that the land area variable significantly affects sugarcane productivity. In sugarcane cultivation, the land area variable has a

Table 2: *Factors affecting sugarcane production*

	Coefficient	Standard-error	t-ratio	P
Beta 0	5,675833***	0,084331	67,30356	0,00
Beta 1 (land area)	0,469454***	0,005948	78,92396	0,00
Beta 2 (seedlings)	0,187037***	0,010309	18,14184	0,00
Beta 3 (fertilizer)	0,041803***	0,007366	5,675125	0,00
Beta 4 (herbicide)	0,018729*	0,010846	1,726774	0,08
Beta 5 (labor)	0,037767**	0,015137	2,494919	0,01
Beta 6 (Plant category)	-0.016342	0,013585	-1,202974	0,23
Delta 0	0,240309***	0,043606	5,510837	0,00
Delta 1 (age)	0,001891	0,011256	0,168006	0,86
Delta 2 (education)	-0,060190***	0,019328	-3,114025	0,00
Delta 3 (experience)	0,001329	0,003216	0,413377	0,67
Delta 4 (number of dependents)	0,082488***	0,022781	3,620795	0,00
Delta 5 (financing pattern)	-0,001519	0,005854	-0,259618	0,79
Delta 6 (credit effectiveness)	-0,079382***	0,007006	-11,329258	0,00
sigma-squared	0,000980	0,000083	11,677525	0,00
gamma	0,999485	0,010168	98,289437	
Log likelihood MLE function = 0,528 Log likelihood function OLS = 0,436 LR test of the one-sided error = 185,040 with number of restrictions = 8				

**** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.*
Source: Primary data processed (2024).

positive coefficient value. Land is most responsive to enhancing sugarcane production compared to other inputs, indicating that land expansion is the main focus if you want to increase sugarcane production. However, land extensification, if not followed by land intensification, will have an insignificant impact on enhancing productivity, so that the two programs can be carried out simultaneously.

The usage of seedlings positively and significantly impacts the output of sugarcane. The coefficient of elasticity of the seedlings is 0,18. An increase of 1 % in seed consumption is anticipated to result in a 0,18% increase in production. The seeds used by farmers are seeds from East Java provided by PG in the form of in-kind credit. If farmers increase the use of seeds, it will increase production, especially if farmers use seeds that come from certified seeds, which is likely to further increase sugarcane production. For this reason PG as a seed provider can provide certified seeds to increase sugarcane production. According to research by (Eliah *et al*., 2024; Setyawati and Wibowo, 2019; Setiawan *et al*., 2023), the outcomes of seedling research have a positive and significant impact on boosting sugarcane production.

The output of sugarcane is positively and significantly impacted by fertilizer application. The fertilizer input's coefficient of elasticity is 0,04. This indicates that a 1 % increase in fertilizer application will result in a 0,04% increase in sugarcane production. The fertilizer used in sugarcane farming is Phonska fertilizer. The fertilizer elements contained in phonska fertilizer are nitrogen, phosphorus, potassium and sulfur. The content in fertilizer will increase the growth of sugarcane in the vegetative period. Phonska fertilizer is a government subsidized fertilizer so that the price is more affordable for sugarcane farmers. The results of research on fertilizer have a positive and significant impact on sugarcane production in accordance with the results of research (Mayangsari, 2024; Mazwan and Masyhuri, 2019; Rahayu *et al*., 2021). In other studies conducted by (Ivanka *et al*., 2019; Wulandari *et al*., 2024; Anggrainingrum *et al*., 2022) stated that the amount of phonska fertilizer used had no significant impact on sugarcane productivity.

The output of sugarcane is positively and significantly impacted by the amount of labor used. The value of 0,018 is the coefficient of labor elasticity. This indicates that a 1% increase in work will result in a 0,018% rise in sugarcane production. In addition to quantity, quality labor is also needed. From soil preparation and processing to planting, upkeep, and harvesting, labor is required throughout the process. High-quality work will result in high-quality output.

The findings of this study are consistent with those of studies (Wulandari *et al.*, 2024; Suwandari *et al.*, 2020; Sandita *et al.*, 2024) that show that labor utilization significantly and favorably affects sugarcane yield. Plant categories do not have a significant effect on sugarcane production. This is because in PG Jatitujuh the planting time for PC and RC plant categories is carried out at the end of the planting season. So that there is no difference in the production of PC and RC sugar cane.

Sigma-squared (σ2) is an additional parameter that represents the sum of the variance values of the effects of noise (vi) and technical inefficiency (ui). According to the analysis, the model utilized is adequate and the errors ui and vi spread normally because the value of σ2 is more than zero at 0,00098 and is statistically significant at the 0,05 level. The gamma (γ) value of 0,999485 shows that technical inefficiency (farmer's internal factors) accounts for 99,94 percent of the error term in the production function, while random error variables (farmer's external factors) like weather, pests, and other uncontrollable factors account for 0,06 percent. This implies that technical inefficiency in the model can be detected by the stochastic frontier production function model that was produced.

Using the MLE approach, Table 2 log likelihood function value of 0,528 is higher than the log likelihood function OLS value of 0,436. This demonstrates that the MLE approach produces a better and more field-representable production function (Coelli, 1996). The value of the LR test of the one-sided error of 185,04 is another parameter that was produced by the frontier analysis. This result exceeds the 14,85 critical value of χ2 (Kode and Palm, 1986). The stochastic frontier production function can explain the technical inefficiency of producers in the production process because the LR test value is higher than the critical value of χ2. This indicates that farmers' farming practices are inefficient and have not reached the 100% efficiency level.

Technical efficiency level of sugarcane farming

Technical efficiency analysis was conducted to determine whether sugarcane farming activities in the working area of PG Jatitujuh have been carried out efficiently. If frontier production or maximum production has been achieved, it is said that farming is fully efficient. If the use of production input can still be increased to achieve full efficiency, then technical efficiency has not been achieved due to inhibiting factors. Technical efficiency can be obtained from the ratio of actual farmer inputs to the frontier output that can be achieved. Technically, farmers who do farming are called efficient if they have a technical efficiency rating ≥ 0.70 as a cut-off value (Darmawan, 2016; Kumbhakar *et al.*, 2015). The distribution of technical efficiency of sugarcane farmers is presented in Table 3.

The data in Table 3 shows that all respondent farmers of sugarcane farming in the working area of PG Jatitujuh have a high level of technical efficiency. Sugarcane farmers in the operational area of PG Jatitujuh exhibit a technical efficiency level exceeding 0,7. The average technical efficiency for farmers who received effective credit is 0.9165, while those with ineffective credit have an average technical efficiency of 0.8738. The potential for production improvement among farmers with effective credit is estimated at 0,0815 (1–0.9165/0.9979). In comparison, the potential for production improvement among farmers with ineffective credit is estimated at 0,1065 (1–0.8738/0.9780). According to (Tajerin, 2007), the high degree of technical efficiency is a reflection of two factors. On the one hand, the high degree of technological efficiency is a reflection of farmers' accomplishments in farm management, which are

Table 3: *Distribution of technical efficiency of sugarcane farming*

Technical Effciency Score	Number of farmers	percentage	Number of farmers	percentage
1. 0,7000-0,8000	1	2,50	13	5,99
2. 0,8000 ≤ ET < 0,9000	14	35,0	129	59,45
3. ≥ 0,9000	25	62,5	75	34,96
Total	40	100	217	100
Average		0,9165		0,8738
Min		0,7723		0,7511
Max		0,9979		0,9780

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adequate and desirable. Since there is little difference between the level of production that has been reached and the maximum level that can be reached with the best management (the best practice), a high level of technical efficiency also indicates that there is a limited opportunity to increase production.

Factors affecting sugarcane farming inefficiency

According to (Orewa and Izekor 2012), in the analysis of the stochastic frontier Cobb-Douglas production model, error can be caused by two sources, namely the first component, vi, which is an external error that cannot be controlled in the model formed. The second component, called ui, is an error that arises as a result of internal factors of farmers or reflects the socio-economic conditions of farmers. Internal farmer factors analyzed in this research include age, education, experience, number of family dependents, financing patterns and credit effectiveness. The analysis's findings, which are shown in Table 2, indicate that the number of family dependents, farmer education, and credit effectiveness are the internal factors influencing inefficiency. The technical inefficiency of sugarcane growing is significantly and negatively impacted by education. A higher level of education among farmers tends to reduce inefficiency. Educated farmers are generally more open to adopting new knowledge and skills in managing sugarcane farming. This finding is consistent with the study conducted by (Astuti *et al*., 2021). The number of family dependents is another element that significantly and favorably affects inefficiency. This means that the more family members will increase inefficiency. Farmers who have many family members usually include their family members to manage the farm. The more family members, the more family labor is used to manage the farm. So that the use of labor becomes excessive or inefficient. The results of this research are in accordance with research conducted by (Wijaya *et al*., 2023) and (Rifaini *et al*., 2022). Credit effectiveness has a negative and significant impact on inefficiency. Farmers who have a high level of credit effectiveness will reduce the level of inefficiency. The more farmers' credit is on time and in the right amount, it will reduce inefficiency so that sugarcane farming is more efficient.

The impact of credit effectiveness on enhancing effiCiency and productivity

Propensity Score Matching (PSM) analysis was the data analysis technique employed to meet the study goals. Because it can correct bias by matching the observation value between the control and intervention groups based on the propensity score, the PSM approach was used. NNM (Nearest-Neighbor Matching) was the matching technique selected.

The propensity score distribution area that shows the similarity between the control group and the intervention group based on the observed socioeconomic characteristics can be seen in the common support area. In this research, the variables of socioeconomic characteristics in the logit model were determined based on issues and interests that can be raised into policies related to factors of farmer credit effectiveness. Farmer credit effectiveness is more effective and significant for farmers with higher education. Table 4 showed that credit effectiveness is weaker and more significant for farmers who have a large number of family dependents and more than one source of loans. A person with higher education in general, based on the prevalence in the community, has a sufficient level of knowledge and insight in looking at everything, including the use of credit or loans. They comprehend the terms and risks of a loan or credit so that they are careful in using the credit. Higher education can also improve decision-making when it comes to the timeliness and amount of credit. They can calculate and estimate the schedule of each farm work with the availability of credit-financed inputs so as not to affect the planting pattern until

Table 4: *Factors affecting the effectiveness of sugarcane farm credit.*

Independent variable	Coefficient	Standard error	Z	P>|z|
Age (year)	-0,000	0,027	-0,01	0,994
Education (years)	0,236**	0,091	2,59	0,010
Experience (years)	-0,006	0,038	-0,18	0,875
Number of family dependents (people)	-0,417**	0,171	2,44	0,015
Land area (ha)	0,858	0,484	1,77	0,076
Side job (have =1, don't have = 0)	0,183	0,382	0,48	0,631
Savings ownership (have = 1, do not have = 0)	-0,220	0,412	-0,53	0,594
Other loan sources (available = 1, not available = 0)	-1,511**	0,458	-3,29	0,001

the harvest is far outside the schedule set by PG. The findings of this study are consistent with those of a study by (Nasution *et al*., 2024).

If farmers have many family dependents, credit has less of an effect. Farmers with a large number of family dependents will likely have higher needs than those with fewer. This affects how farmers behave to provide for their families (Wijaya *et al*., 2023). In addition, the large number of family dependents puts greater pressure on farmers so that the tendency is to potentially reduce the flexibility of the use of farm inputs obtained from credit (Mango *et al*., 2015) The excess amount of input can be utilized for the next period of farming or returned to PG so that it will increase income at the end of the period, with a record of crop input needs having been met. Some undesirable behaviors among farmers include not returning the excess inputs. In some cases, the inputs are not used for sugarcane cultivation but are instead sold to others (misuse of credit) to meet household needs. Such occurrences may happen; however, they are difficult to analyze because farmers consistently report that all inputs are used for farming purposes. The presence or absence of other sources of credit affects the effectiveness of credit. If farmers have different sources of loans other than KUR, it will affect the effectiveness of the KUR. This research follows the results of research (Farida *et al*., 2016) which states that other loan sources affect KUR.

The impact of credit effectiveness on technical efficiency

Analyzing how credit effectiveness affects sugarcane farming's technical efficiency comes next, after determining the elements that affect credit effectiveness. Farmers were split into two groups based on credit effectiveness: those with effective credit and those with ineffective credit. The farmers with effective credit were designated as the treatment group, whereas the farmers with ineffective credit were designated as the control group. Table 5 displays the findings of the data analysis.

Table 5 data analysis results utilizing PSM show the Average Treatment Impact on the Treated (ATT) value. If farmers employ effective credit (D=1), the ATT value is interpreted to determine the impact on technical efficiency; however, in practice, farmers do not use effective credit (D=0). The ATT value, which is 0.031 (3.1%), indicates that the technical efficiency of sugarcane farmers who use effective credit differs significantly from that of those who do not, at the 5% real level. The average technical efficiency level of sugarcane farmers with effective credit was 0.920 (92.0%). There is 8% room to improve technical efficiency to make sugarcane farmers using effective credit fully efficient. Meanwhile, the average technical efficiency level of sugarcane farmers who do not use effective credit was 0.889 (88.9%). There is 11.1% room to improve technical efficiency to make sugarcane farmers who do not use effective credit fully efficient. Both sugarcane farms that utilize effective credit and those that employ ineffective credit are technically efficient based on the average degree of technical efficiency. According to (Khumbakar and Lovell, 2000), farming is considered efficient if its technical efficiency index is more than 0.70. The findings of this study support those of a study by (Matsvai *et al*., 2022) that found microcredit can increase the technical efficiency of sugarcane production. According to research findings, the technical efficiency of sugarcane growing will rise when farmers are not subject to loan limitations (Maharani, 2024).

The impact of credit effectiveness on sugarcane farm productivity

A high technical efficiency value indicates the potential for increasing productivity. In this research, the productivity measured is land productivity. To increase sugarcane productivity, one of the ways that can be carried out to increase technical efficiency. Inputs and costs that are not used in a timely manner will cause obstacles for farming. Likewise, inputs and costs that are not used or issued in the right amount will also be an obstacle to farming. Farmers who have effective credit, namely the use of credit that is

Table 5: *Impact of credit effectiveness on technical efficiency of sugarcane farming*

Outcome variable	Sample	Treated	Control	Difference	S.E	T Stat
Technical	Unmatched	0,920	0,873	0,047	0,008	5.79***
Efficiency	ATT	0,920	0,889	0,031	0,012	2.56**

Notes: * *significant at significance level* α=*10% (|z| > z-table: 1.651)*
** *significant at the* α=*5% significance level (|z| > z-table: 1.970);*
*** *significant at* α=*1% significance level (|z| > z-table: 2.596)*

Table 6: *Impact of credit effectiveness on sugarcane farm productivity*

Outcome variable	Sample	Treated	Control	Difference	S.E	T stat
Productivity	Unmatched	468,825	449,898	18,926	4,472	4,23***
	ATT	468,825	447,650	21,175	6,282	3,37***

*Notes: * significant at significance level α=10% (|z| > z-table: 1.651)*
*** significant at the α=5% significance level (|z| > z-table: 1.970);*
**** significant at α=1% significance level (|z| > z-table: 2.596)*

on time and in the right amount, will be able to use inputs in accordance with the amount and time when needed, resulting in greater conformity and increased productivity potential. The results of data analysis on the impact of credit effectiveness on productivity are presented in Table 6.

The productivity differential between sugarcane farmers who use effective credit and those who do not, which is 21.175 quintals/ha, is substantial at the 1% real level, according to the ATT value. 468.825 quintals/ha is the average production of sugarcane farmers who use adequate finance. Conversely, sugarcane producers who did not employ effective credit had an average production of 447.650 quintals per hectare. The findings of this study support those of studies by (Maharani, 2024) and (Louyindoula *et al*., 2023), which claim that unfettered credit will boost production. When credit is restricted, it means that credit cannot be used to purchase and use the right amount of inputs as needed.

Conclusions and Recommendations

The measurement of credit effectiveness in sugarcane farming among partner farmers of PG Jatitujuh, Majalengka Regency, was carried out with the aim of classifying farmers whose credit is effective and those whose credit is not yet effective. The classification of farmers based on the calculation of credit effectiveness scores is a contribution of the study. Credit effectiveness can be a predictor of technical efficiency because effective credit directly influences farmers' ability to manage inputs. The factors influencing sugarcane production include land area, the amount of seeds used, the amount of fertilizer used, herbicides, and the number of laborers employed. The technical efficiency level and productivity of farmers with effective credit is higher than that of farmers whose credit is not yet effective. This implies that when farmers receive credit on time and in the right amount, the provision and use of inputs will be in accordance with Good Agricultural Practices (GAP), and the quantity of inputs obtained from the credit will match the needs or the recommended dosage for sugarcane crops. This condition will encourage farmers to use inputs more efficiently. The factors affecting technical inefficiency are education, family size, and credit effectiveness. Credit effectiveness is higher and more significant among farmers with higher education levels. On the other hand, credit effectiveness decreases and remains significant among farmers with larger family sizes and those who have more than one source of loans.

Generally, a person with higher education, based on common norms in society, tends to have sufficient knowledge and insight to consider various matters, including the prudent use of credit or loans. Credit tends to become less effective if farmers have many dependents, as they require greater household needs compared to farmers with fewer dependents. The presence or absence of other loan sources also affects whether the credit is effective or not. If a farmer has another loan source in addition to the KUR credit, it can influence the effectiveness of the KUR credit. The technical efficiency level and productivity of farmers with effective credit are higher than those of farmers whose credit is not yet effective. More efficient use of inputs will have an impact on increased productivity.

Credit effectiveness for farmers needs to be improved so that the number of farmers with effective credit increases. As the credit distributor, PG must have a credit distribution mechanism that is both timely and in the appropriate amount. To ensure that credit is distributed to farmers on time, PG can anticipate potential delays in advance. For example, if the distribution of subsidized fertilizer is delayed, PG should be able to provide affordable non subsidized fertilizer as an alternative. Efforts to intensify sugarcane farming are necessary, as merely expanding the planting area (extensification) does not guarantee increased productivity. One example of intensification is the use of superior seed varieties, improving irrigation systems such as by adding water reservoirs (embung) for irrigation and promoting the use of organic fertilizers through farmer outreach programs.

Acknowledgements

I (Dina Dwirayani) sincerely express my gratitude to IPB University (Bogor Agricultural University) for granting me the opportunity to pursue my doctoral studies. I also extend my deepest appreciation to University of Swadaya Gunung Jati for awarding me a scholarship to continue my PhD program.

Novelty Statement

This study provides the first empirical assessment of how credit effectiveness influences technical efficiency and productivity in sugarcane cultivation.

Author's Contribution

Dina Dwirayani: Conceptualized the study, collected and analyzed the data, and drafted the manuscript.
Nunung Nuryanto, Dwi Rachmina, and Amzul Rifin: Supervised the research and provided intellectual guidance on the research idea, methodology, problem formulation, objectives, and novelty of the study.

Generative AI or AI assisted technology statement
The authors acknowledge the use of AI-assisted tools (e.g., grammar and language editing software) solely for improving the readability of the manuscript, and confirm that all intellectual content was created by the authors.

Conflict of interest
The authors have no conflict of interest.

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