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Technical Efficiency of Smallholder Sugarcane Farming in the Plant Cane Category on Dry Land in the Working Area of Ngadiredjo Sugar Factory, East Java Province

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ABSTRACT

This study aims to analyse technical efficiency (TE) of smallholder sugarcane farming, factors affecting of TE, and farm profitability using the Profit-Sharing System (SBH) and Sugarcane Purchasing System (SPT) partnership schemes. The research location is in the Ngadiredjo Sugar Factory work area. Research methodology using DEA, Tobit regression, and sugarcane farming analysis in each partnership scheme. The results of the analysis showed that the average TE value of smallholder sugarcane farming on dry land is 0,91 (91%) and still had the potential to be increased by 0,9 (9%). Factors that influence the TE level are the role of the Ngadiredjo Sugar Factory in developing its partner farmers. The average income and RC ratio value (actual and target) obtained (after efficiency) in the SBH partnership were respectively IDR 13.44 million/ha and IDR 18.07 million/ha, while in the SPT partnership they were respectively IDR 2.69 million/ha and IDR 7.3 million/ha. The RC ratio value of existing smallholder sugarcane farming (actual) is 1.18. While in the SPT partnership scheme the RC Ratio value is 1.03. Based on the value of income, RC ratio, and sugarcane farming assumption used the SBH partnership is better than the SPT partnership scheme.

Keywords: Sugarcane, Technical Efficiency, DEA, Profitability

INTRODUCTION

The Acceleration of National Sugar Self-Sufficiency and the Provision of Bioethanol as Biofuel in Presidential Regulation (Perpres) No. 40 of 2023 has the aim of realizing food and energy security, promising the availability of raw materials, especially industrial auxiliary materials, realizing the welfare of sugarcane farmers and realizing energy security and the implementation of clean energy by utilizing bioethanol-based biofuel. The Presidential Regulation has set a sugarcane productivity target of 93 tons per hectare, an increase in land area of 700 thousand hectares, an increase in Commercial Cane Sugar (CCS) of 11.2 percent, an increase in the welfare of smallholder sugarcane farming, and bioethanol production. The target for sugar self-sufficiency in 2028 for household consumption sugar and 2030 for industrial consumption sugar (Presiden RI, 2023).

East Java Province has been named as the national sugar granary with a contribution of 49.62% of the 2.27 million tons (total national sugar production) in 2023. The performance of

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sugarcane land area, cane productivity and CCS all affect this performance. In the last five years in East Java, the performance of sugarcane land area increased by 11.28 percent per year on average, while sugarcane productivity decreased by 15.61 percent per year on average and CCS increased (stagnated) by 0.01 percent per year on average. Both the increasing trend of auction sugar prices and smallholder sugarcane farming influenced the increase in sugarcane area. In contrast, sugarcane productivity has decreased due to fertilization, rainfall, increased sugarcane farming costs, and sugarcane cultivation facilities (agricultural machinery) (Fahriyah et al., 2018; Hartatie & Harlianingtyas, 2020; Permadhi & Dianpratiwi, 2021). This can have an impact on farmers' income due to partnership schemes implemented by Sugar Factory and smallholder sugarcane farming, such as the use of Profit Sharing System (SBH) or Sugarcane Purchasing System (SPT) (Yusvianto & Kuntadi, 2022).

All Sugar Factories in East Java are still unable to maximize efforts to increase cane and sugar productivity. Until now, sugarcane productivity has reached 72.05 tons per hectare with a CCS of 7.8 percent. The performance that has been achieved is still far from the 2030 performance target, which is 21 tons per hectare of sugarcane productivity and 3.4 percent CCS. Therefore, it is very important to conduct research on Technical Efficiency (TE) to increase the productivity and income of smallholder sugarcane farming efficiently. To encourage increased sugarcane productivity and CCS, TE efforts must also consider Good Agriculture Practices (GAP). This effort must be supported by relevant stakeholders such as Sugar Factory, Agriculture Department, Smallholder Sugarcane Farming Association (APTR) must also support this effort (Kadarwati et al., 2016). In a long-term perspective, it is expected that efforts to increase TE can improve the partnership ecosystem. Reduced costs and increased income will attract smallholder sugarcane farming to expand their land. This land expansion will have implications for the stability of sugarcane supply at the Sugar Factory, thus encouraging efficiency and increasing CCS at the Sugar Factory.

One of the Sugar Factory in East Java Province is Ngadiredjo Sugar Factory, Kediri Regency. PT Sinergi Gula Nusantara (SGN) operates Ngadiredjo Sugar Factory in Kediri, which is an important part of their business. This factory converts sugarcane into white crystal sugar and molasses. The white crystal sugar produced is used as a natural sweetener for various purposes, both in households and in industry (Nazri & Artono, 2024). Ngadiredjo Sugar Factory has contributed 53.4 thousand tons (4.74%) of the total sugar production in East Java in 2023. In the last 5 (five) years, the performance of sugarcane land area in Ngadiredjo Sugar Factory recorded an increase in average land area of 5.68 percent, sugarcane productivity increased by 1.15 percent, and CCS by 1.23 percent each year (2019-2023). The increase in land area performance trend occurred due to an increase in sugar prices which had an impact on the high income of smallholder sugarcane farming. Sugarcane farmers currently face a number of issues, including the need for production inputs, farm capital, and institutions that can deliver their produce to sugar factories. The actual condition of the joint business groups in Kediri City before and after the partnership program is that their income and productivity were low before the partnership program due to input and output price and market issues(Setiawan & Hendrarini, 2024). Ngadiredjo Sugar Factory made efforts to increase sugarcane productivity, especially in Kediri District by providing assistance to sugarcane farmers. The assistance

carried out includes several activities such as, providing education starting from how to plant sugar cane to the harvest process. In addition, farmers who partner with Ngadiredjo Sugar Factory are given capital to plant sugarcane so that they can only wait for profit sharing with Ngadiredjo Sugar Factory.

One of the solutions to the above problems and efforts to fulfill the targets in Presidential Regulation No. 40 of 2023, it is important to conduct this research to: (1) Analyze the TE of smallholder sugarcane farming in Ngadiredjo Sugar Factory working area; (2) Analyze the factors affecting the TE of smallholder sugarcane farming in Ngadiredjo Sugar Factory working area; and (3) Analyze the profitability of smallholder sugarcane farming with SBH and SPT partnership schemes in Ngadiredjo Sugar Factory working area.

Table 1
Sugarcane/Sugar Production Performance in the Working Area of Ngadiredjo Sugar Factory in Kediri and Sugar Factories in Java

Category	Sugar Factory	2019	2020	2021	2022	2023
Land Area (Ha)	Ngadirejo	9,053	5,564	5,569	9,598	8,526
	East Java	153,971	144,128	194,458	218,193	227,746
Sugarcane Production (**000** Ton)	Ngadiredjo	690,741	450,259	469,056	840,976	673,102
	East Java	16,482.56	14,367.46	15,679.69	12,080.19	11,963.**23**
Sugarcane Productivity (Ton/Ha)	Ngadiredjo	76.30	80.92	84.23	87.62	78.95
	East Java	107.05	99.69	80.63	55.36	52.53
CCS (%)	Ngadiredjo	8.32	7.29	7.14	6.72	7.94
	East Java	5.56	5.29	6.87	9.63	9.42
Sugar Production (**000** Ton)	Ngadiredjo	57,471	32,821	33,505	56,531	53,458
	East Java	915,84	760,51	1,076.86	1,163.75	1,126.79
Sugar Productivity (Ton/Ha)	Ngadiredjo	6.35	5.90	6.02	5.89	6.27
	East Java	5.95	5.28	5.54	5.33	4.95

Source: Secondary data (Directorate General of Plantation's Final Evaluation Report 2019-2023)

RESEARCH METHOD

The research method used is the survey method and structured questionnaires as a primary data collection tool regarding sugarcane farming and partnership ecosystems to obtain good information from research samples in a particular population (Singarimbun & Efendi, 2008). The research location was purposively selected, namely in the working area of Ngadiredjo Sugar Factory. The determination of this research location is based on the criteria of the research location which is the working area of Ngadiredjo Sugar Factory. The analysis method in this research is using quantitative analysis method.

The technique of determining the sample of smallholder sugarcane farming in this study was taken by a simple random sampling using the Slovin formula as follows (Cahyono & Rahmi, 2021):

$$n = \frac{N}{1 + N\,(e)^2}$$

Where:
n : Number of Samples
N : Total Population
e : % Error (0,1)

The first stage in determining the sample of smallholder sugarcane farming was to determine the distribution of farmer locations representing the eastern, western, northern and southern regions in the working area of Ngadiredjo Sugar Factory. Then, in the second stage, information was sought about the population of Ngadiredjo Sugar Factories partner farmers who had garden plots in the Plant Cane (PC) with Bululawang (BL) sugarcane varieties on dry land in the 2022-2023 planting season. The total population of smallholder sugarcane farming was 98. Using the Slovin formula above, the total sample population of small-scale sugarcane farmers in this study was at least 49.49 or 50 respondents. The following is the distribution of the research respondents' locations within the Ngadiredjo Sugar Factory work area.

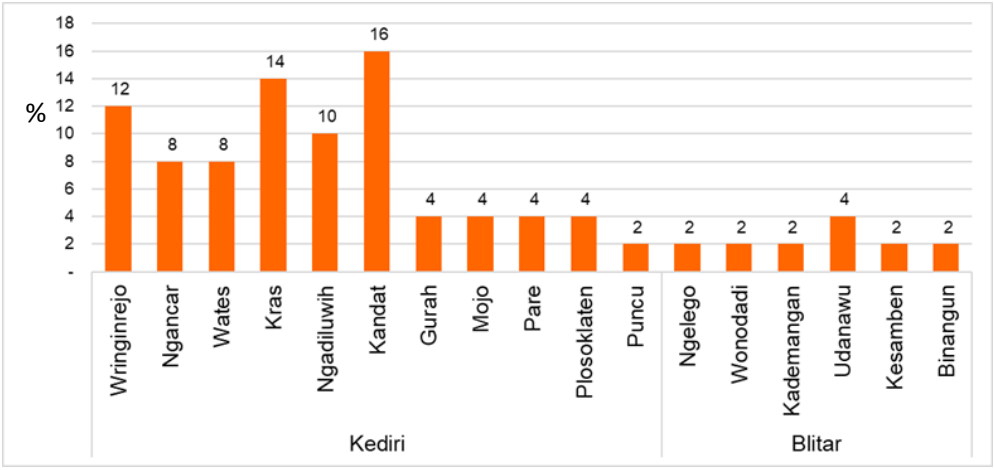


Figure 1
Distribution of Research Respondents in Ngadiredjo Sugar Factory Working Area (%)

Respondents were spread across two districts, namely Kediri and Blitar. The largest percentage of Kediri District with the most partner farmers are in Kandat (16%) and Kras (14%) sub-districts, while in Blitar District only a small percentage of farmers are scattered in Udanawu sub-district (4%) on the border with Kediri District.

The analysis method in this research is as follows:

1. Technical Efficiency Analysis of Smallholder Sugarcane Farming

TE is the ability of a farming business to obtain maximum output by using inputs together (Fahriyah *et al.*, 2018). TE measurement uses Data Envelopment Analysis (DEA), which is a method to evaluate the productivity of a work unit or called a DMU (Decision Making Unit) that uses a number of inputs to produce targeted outputs. The measurement of TE in this study will simply be expressed in the form of a ratio between output and input (Davis, 2018; Fatimah & Mahmudah, 2017). DEA can be used on multiple inputs and outputs. The inputs used in this study consist of: (1) land area (ha); (2) seed (qu/ha); (3) ZA fertilizer (qu/ha); (4) NPK fertilizer (qu/ha);

(5) herbicide (liter); and (6) labor (Man-day), while the resulting output is total sugarcane productivity (qu/ha). The DEA method in this study uses input orientation and the concept of VRS (Variable Return to Scale) because it is considered that smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory are still not at an optimal scale or in other words, the addition of X number of inputs does not produce or does not necessarily result in the addition of X number of outputs (Banker *et al.,* 1984; Emrouznejad *et al.,* 2025). Suppose if there are n farmers producing a single product with the use of K inputs, then to measure the input-oriented TE of farmer j, the following linear programming problem is solved:

$min_{\theta,\lambda_i,i=1..n}\theta$ .....(1)

Subject to:

$\sum_{i=1}^{n} y_i\, \lambda_i \geq y_j$ .....(2)

$\sum_{i=1}^{n} x_{ki}\lambda_i \leq \theta\, x_{kj}, k = 1,2,\ldots,K$ .....(3)

$\sum_{i=1}^{n} \lambda_i = 1$ .....(4)

$\lambda_i \geq 0$ .....(5)

Where θ is the input-oriented TE ratio of farmer j, y_i is the amount of output produced from farmer i, where i = 1, 2, ..., j, ..., n, and n is the number of farmers, xki is the amount of input k applied by farmer i (for i = 1, 2, ..., j, ..., n) for k = 1, 2, ..., K, where K is the amount of input used by the farmer and $\{\lambda i\}$ n is the weight to be determined. Note that there is an equation for K in Equation (3). The above model, given in Equations (1)-(4), is solved for farmer j in order to obtain the optimal value of the objective function, θ* being the input-oriented TE measure of farmer j ($\mathrm{TE}j$):

$\mathrm{TE}j = \theta^*$ .....(6)

This measure of TE satisfies the constraint $0 < \theta^* \leq 1$, where a value of 1 indicates a fully efficient smallholder sugar factory. Thus, the above problem is solved to obtain θ^* for each farmer (for j = 1, 2, ..., n).

2. Analysis of Factors Affecting the Technical Efficiency

The Tobit method is based on the assumption that all variables (both independent and dependent) are measured accurately, there is no autocorrelation, homoscedasticity is maintained, there is no perfect multicollinearity, the applied mathematical model is accurate, and the independent variables are not limited in value (non-censored), while only the dependent variable is censored. Tobit regression is applied to analyze censored data, where the response variable has a value of zero in some observations but shows varying values in other observations. The TE measure obtained from the DEA assessment is based on a regression model that shows the correlation between TE and the associated sugarcane and institutional characteristics.

Potential factors that are estimated to affect the TE of smallholder sugarcane farming in the research location are: age, education, sugarcane farming experience, number of family dependents, the role of sugar factory, the role of financial institutions, the role of APTR and the role of the Agriculture Department. The following is the Tobit regression formulation applied in this study according to (Amemiya, 1984; Pratama *et al.,* 2024)

$TE = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5D1 + \beta6D2 + \beta7D3 + \beta8D4 + \varepsilon$

Where:

TE : Technical Efficiency
β0 : Coefficient
X1 : Farmer age (years)
X2 : Farmer education (years)
X3 : Sugarcane farming experience (years)

X4 : Number of family dependents (people)
D1 : Dummy variable for role of Sugar factory (1= present; 0= absent)
D2 : Dummy variable for role of Financial Institution (1= present; 0= absent)
D3 : Dummy variable for role of APTR (1= present; 0= absent)
D4 : Dummy variable for role of the Agriculture Department
(1= present; 0= absent)
ε : Error term

3. Profitability Analysis of Smallholder Sugarcane Farming

The analysis of smallholder sugarcane farming profitability in this study uses two partnership schemes, namely SBH and SPT partnerships. Farmers involved in the SPT and SBH partnership systems work based on the following assumptions:

a. Sugarcane farming analysis is carried out using the assumption of units per hectare.
b. All costs associated with sugarcane farming are considered equivalent to loans received from financial institutions (Bank/KUD/KPTR) with an average interest rate of 7%.
c. Determination of sugarcane prices according to the average price of sugarcane for the 2023 milling season of IDR 75,000/qu in East Java.
d. Determination of sugar prices according to the average price of farmer auction sugar smallholder sugarcane farming for the 2023 milling season of IDR 13,200/kg in East Java.
e. SBH partnership general formula:

Table 2
SBH Scheme General Formula in Ngadiredjo Sugar Factory Working Area

No.	CCS (%)	Sugar Amount for Farmers (%)	Sugar Amount for Sugar Factory (%)
1	<6.00	66.00	34.00
2	≥6.00-7.00	70.00	30.00
3	>7.00-7.50	72.00	28.00
4	>7.50-8.00	74.00	26.00
5	>8.00-8.50	76.00	24.00
6	>8.50%	80.00	20.00

Source: Secondary data (PT Sinergi Gula Nusantara, 2024)

f. Sugarcane farmers receive a share of molasses amounting to 3.5% of the amount of sugarcane delivered to the partner sugar factory. With the average price of molasses according to the 2023 milling season auction of IDR 2,500/Kg.
g. It is assumed that smallholder sugarcane farming do not invest or allocate Fix Cost (FC).

Analysis of sugarcane farming with SPT partnerships can be calculated using the following formula:

TC (IDR/Ha) SPT = (FC+VC) + Bank Interest Rate
Bank Interest Value (IDR) = % Bank Interest x (FC+VC)
TR of Sugarcane (IDR/Ha) = IDR 75,000 x Sugarcane Weight (Qu)
Income (π) (IDR/Ha) = TR Sugarcane - TC SPT
R/C Ratio = TR/TC SPT
BEP Quantity of Sugarcane (Qu/Ha) = TC SPT / Sugarcane Price (IDR/Qu)
BEP Sugarcane Price (IDR/Qu) = TC SPT / Quantity of Sugarcane (Qu/Ha)

The sugarcane farming analysis of the SBH partnership can be calculated using the following formula:
TC_{SBH} (IDR/Ha) = (FC + VC - Bank Interest Rate) - $TR_{Molasses}$
Bank Interest Value (IDR) = (FC+VC) x % Bank Interest
$TR_{Molasses}$ (IDR/Ha) = (Sugarcane Production x 3% x 1000) x Price of molasses (IDR/Kg)
TR_{Sugar} (IDR/Ha) = (Sugarcane Production x CCS) x Percent Total Amount Share for Farmer x 1000) x Sugar Price (IDR/Kg)
Income (π) = TR_{Sugar} - TC_{SBH}
R/C Ratio = TR_{Sugar} / TC_{SBH}
BEP Quantity of Sugar = TC_{SBH} / Sugar Price (IDR/Kg)
BEP Sugar Price = TC_{SBH} / Quantity of Sugar (Qu)
BEP CCS (%) = (BEP Quantity of Sugar / (Sugarcane quantity x100)) * 100
Where:

FC : Fixed Cost (IDR/Ha)
VC : Variable Cost (IDR/Ha)
TC : Total Cost (IDR/Ha)
TR : Total Revenue (IDR/Ha)
π : Income (IDR/Ha)
R/C : Business feasibility (>1: Feasible; <1: Unfeasible; =1: Break-even)
BEP : Break Event Point

RESULT AND DISCUSSION

1. TE Analysis Smallholder Sugarcane Farming of Ngadiredjo Sugar Factory

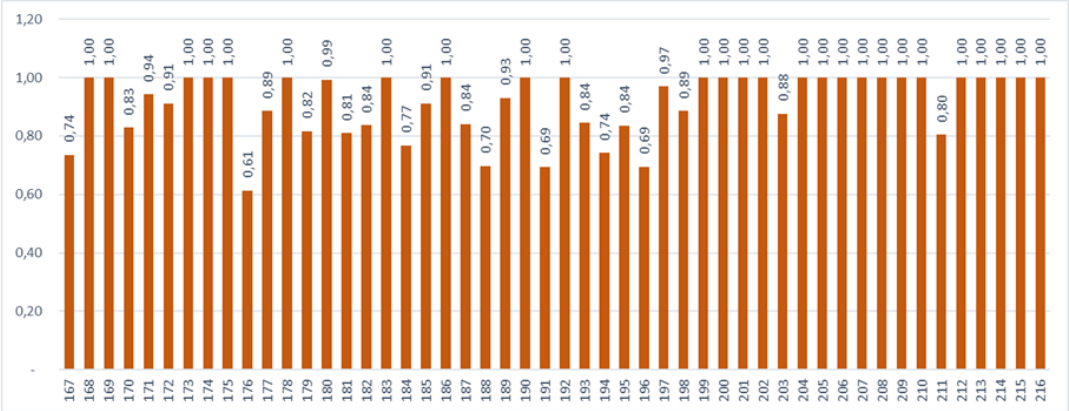
The calculation results show that the percentage of DMUs with a TE score = 1 (TE) is higher than that of DMUs with a TE score < 1 (technically inefficient). The TE score distribution table below shows that the highest proportion is DMU with a TE score of 1 as many as 26 respondents (52.00%). The average level of pure TE (TE VRS) was 0.91, while the average TE Contant Return to Scale (TE CRS) level reached 0.86. The following table of TE score distribution in the Ngadiredjo Sugar Factory working area shows that farmers who have the highest efficiency score are 26 respondents (52.00%) for TE VRS and 19 respondents (38.00%) TE CRS. The average score for TE is 0.91 (91%) which means that smallholder sugarcane farming in the Ngadiredjo Sugar Factory working area can increase the average by 9% by reducing the use of production inputs. The following table shows the distribution of TE scores in the Ngadiredjo Sugar Factory working area.

Table 3
Distribution of TE Score in Ngadiredjo Sugar Factory Working Area

TE CRS			TE VRS			Efficiency Scale		
Value	**Freq.**	**%**	**Value**	**Freq.**	**%**	**Value**	**Freq.**	**%**
1.00	19	38.00	1.00	26	52.00	1.00	21	42.00
0.90-0.99	9	18.00	0.90-0.99	6	12.00	0.90-0.99	16	32.00
0.80-0.89	4	8.00	0.80-0.89	11	22.00	0.80-0.89	8	16.00
0.70-0.79	10	20.00	0.70-0.79	4	8.00	0.70-0.79	5	10.00
0.60-0.69	8	16.00	0.60-0.69	3	6.00			
Average	**0,864**		**Average**	**0,917**		**Average**	**0,939**	

Source: Primary Data, Processed (2024)

Smallholder sugarcane farming dominates in the working area of Ngadiredjo Sugar Factory with a score of 1.00, which can be said to be TE in the use of inputs. However, on average, smallholder sugarcane farming of Ngadiredjo Sugar Factory still can obtain maximum CCS like smallholder sugarcane farming. Below (see Figure 2) is the distribution of TE scores of smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory.

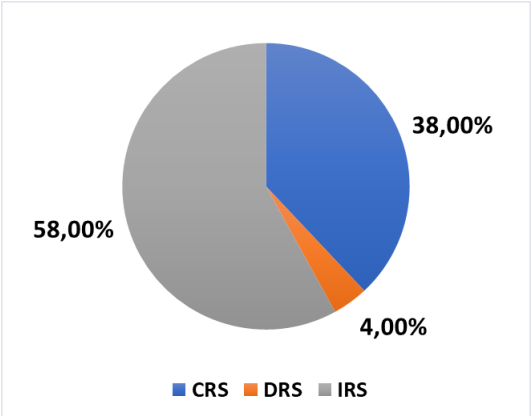


Source: Primary Data Processed, (2023)

Figure 2

Distribution of TE Score in Ngadiredjo Sugar Factory Working Area

Smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory as many as 24 respondents or 48% have an efficiency score value <1.00 with an efficiency score range of 0.61-0.99, which means that smallholder sugarcane farming can increase the TE value by 3.00-39.00% to make the use of inputs more efficient.



Source: Primary Data Processed, (2023)

Figure 3.

Distribution of Scale Efficiency in the Ngadiredjo Sugar Factory

The average production inputs that can be reduced are in sugarcane land management averaging 32.60%, sugarcane seeds averaging 2.55%, ZA

fertilizer averaging 18.33%, NPK fertilizer averaging 3.38%, herbicides averaging 17.46%, and the number of workers averaging 16.6%. The following is a more detailed presentation of the average actual and target values of production input reductions that can be made by partner smallholder sugarcane farming in the Ngadiredjo Sugar Factory working area.

Table 4
Average Actual and Target Values of TE of Smallholder Sugarcane Farming in Ngadiredjo Sugar Factory Working Area

No.	Category	Actual Value	Target Value	Difference (%)
1	Land Area (Ha)	11.19	7.54	-32.60
2	Seed (Qu)	107.78	105.03	-2.55
3	ZA fertilizer (Qu)	8.48	6.93	-18.33
4	NPK fertilizer (Qu)	7.47	7.22	-3.38
5	Herbicide (Liter)	7.77	6.41	-17.46
6	Labor (Man-day)	251.78	211.10	-16.16

Source: Primary Data Processed, 2024

2. Factors Affecting the TE of Smallholder Sugarcane Farming in the Ngadiredjo Sugar Factory Working Area

TE of smallholder sugarcane farming in Ngadiredjo Sugar Factory working environment ($Y_{ET\ Ngadiredjo}$) is the dependent variable that will be regressed. The variables to be regressed are X1, X2, X3, X4, D1, D2, D3, and D4. The following table shows the regression results between TE, individual characteristics, and related institutions:

Table 5
Results of Factor Analysis of the Effect of TE of Smallholder Sugarcane Farmingin Ngadiredjo Sugar Factory Working Area

Variables	Coefficient	t-count	Sig.
(Constant)	0.748	5.154	0.000
(X1) Age	0.002	1.084	0.285
(X2) Education	0.000	-0.024	0.981
(X3) Farming Experience	-0.002	-0.961	0.342
(X4) Family Dependents	0.001	0.040	0.968
(D1) Dummy variable for role of Sugar factory	0.130	2.824	0.007*
(D2) Dummy variable for role of Financial Institutions	-0.007	-0.150	0.881
(D3) Dummy variable for role of APTR	-0.033	-0.644	0.523
(D4) Dummy variable for role of Agriculture Department	0.031	0.488	0.628
R2		0.470	
F-count		1.453	
F-table		2.13	
T-table		1.303	

Notes: * Significant at 80% confidence level

Source: Primary Data Processed, 2024

From the test data, the regression equation is obtained as follows:

$Y_{ET\ Ngadiredjo} = 0.748 + 0.002X1 + 0.000X2 - 0.002X3 + 0.001X4 + 0.130D1 - 0.007D2 - 0.033D3 + 0.031D4 + ui$

The regression results above show whether the variation in the model can explain the variation in the dependent variable which is indicated by the F-count value of 1.453 with an F-table of 2.13 with a sig level. 5% shows that F-count> F-table means that simultaneously the independent variable affects the dependent variable. The percentage of variation in the dependent variable can be explained by the R-Squared model which shows a value of 0.470 which means that the independent variable can explain the dependent variable by 47% and the rest is explained by other variables by 53%.

Partial test (t-test) is used to determine the effect of each independent variable on the dependent variable or the absence of the effect of the independent variable on the dependent variable. This can be known from the value of t-count> t-table or t-count < t-table with a sig.0.20 value which indicates an influence on the dependent variable such as D1 (role of sugar factory). In contrast, the variables X1, X2, X3, X4, D2, D3, and D4 show the value of t-count < t-table with a sig value 0.10 which means that there is no influence on the dependent variable.

The role of Ngadiredjo Sugar Factory (D1) significantly influenced the TE of smallholder sugarcane farming with a coefficient value of 0.130 and obtained a positive value. The role of sugar factory means that it can increase the TE of smallholder sugarcane farming by 0.130. The roles performed by Ngadiredjo Sugar Factory officers include: (1) Inviting all partner smallholder sugarcane farming in the Partnership Meeting Forum (FTK) at the beginning and end of the mill; (2) Escorting partner smallholder sugarcane farming activities by carrying out LAKU activities (training and visits); (3) Helping facilitate the capital needs of smallholder sugarcane farming; (4) Helping facilitate the needs of facilities and production of smallholder sugarcane farming.

3. Profitability of Smallholder Sugarcane Farming in Ngadiredjo Sugar Factory Working Area

The total actual cost calculated from the sum of land rent, labour, inputs, Cut Load Transport and bank interest (7%) in the working area of Ngadiredjo Sugar Factory is IDR 83,004,016. This cost can be reduced to IDR 73,246,327, - after TE of IDR 4,327,520, - if the receipt of drops reaches 3,427.80 kg (3% CCS of total sugarcane) with an average price of IDR 2,500, - per kg, then the receipt of drops is IDR 8,569,500, -. Thus, the actual total cost after deducting the molasses revenue is IDR 74,434,516 and can be reduced after TE to IDR 69,84,070. The total cost before the reduction of molasses revenue is the total cost of the SPT partnership scheme, while the total cost after the reduction of molasses revenue is the total cost of the SBH partnership. Below are the details of the average smallholder sugarcane farming costs in the working area of Ngadiredjo Sugar Factory.

The average productivity of smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory is 1,142.60 qu/ha, much higher than the average productivity of East Java sugarcane (694.50 qu/ha) and in the working areas of the research Sugar Factories (726.80 qu/ha) in 2023. This average productivity will have an impact on smallholder sugarcane farming revenue and income in the Ngadiredjo Sugar Factory working area. There are two partnership schemes, namely SPT and SBH.

SBH has a scheme regarding the average CCS value of smallholder sugarcane farming which is 7.87%. Sugar production is obtained at 8,997 kg with the amount of sugar shared by smallholder sugarcane farming amounting to 74% of the total sugar production is 6,657 kg. If the average auction sugar price of smallholder sugarcane farming is IDR 13,200 per kg, then total revenue of smallholder sugarcane farming is IDR 87,881,059. In the SBH scheme, the average income is obtained from the value of revenue minus total costs at actual and target values that have been carried out TE on several inputs of inputs and labour. The average actual income was obtained at IDR 13,446,543, - and there was additional potential after efficiency, the average income which was originally IDR 4,630,446, - increased to IDR 18,076,989, -.

Table 6
Average Smallholder Sugarcane Farming Costs in Ngadiredjo Sugar Factory Working Area

No	Component	Actual Value				Target Value				Difference (IDR)
		Total	Unit	Unit Cost (IDR)	Total Cost (IDR)	Total	Unit	Unit Cost (IDR)	Total Cost (IDR)	
1	Land Rental Fee	1	Ha	23,090,000	23,090,000	1	Ha	23,090,000	23,090,000	-
2	Working Fee	251.78	Man-day	73,401	18,480,892	211.10	Man-day	73,401	15,495,052	(2,985,840)
3	Agricultural Production Facilities costs									-
a	Seeds	107.78	Qu	86,818	9,357,200	105.03	Qu	86,818	9,118,600	-238,6
b	Za Fertilizer	8.48	Qu	465,555	3,947,440	6.93	Qu	465,555	3,224,002	-723,438
c	NPK Fertilizer	7.47	Qu	793,259	5,926,276	7.22	Qu	793,259	5,726,091	-200,185
d	Organic Fertilizer	61	Qu	22,843	1,382,639	61	Qu	22,843	1,382,639	-
e	Herbicides	7.77	Lt	132,304	1,028,000	6.41	Qu	132,304	848,544	-179,456

	BBM	3.50	Lt	100,286	351	3.50		100,286	351	-
4	Cut Load Transport Cost	1.142	Qu	12,262	14,010,400	1.142		12,262	14,010,400	-
	Total Cost				77,573,847				73,246,327	(4,327,520)
5	Bank Interest (7%)				5,430,169				5,127,243	-302,926
	Total Cost + Bank Interest				83,004,016				78,373,570	(4,630,446)
6	Revenue of Molasses (3%)	3.427	Kg	2,500	8,569,500	3.427	Kg	2,500	8,569,500	-
	(Total Cost + Bank Interest) – Revenue of Molasses				74.434.516				69.804.070	(4.630.446)

Source: Primary Data, processed (2024)

The SPT scheme only takes into account the weight and price of sugarcane per quintal. In this study, the average sugarcane price per quintal in East Java province in 2023 is IDR 75,000. Thus, smallholder sugarcane farming who choose the partnership will receive an average TR is IDR 85,695,000. In the SPT scheme, the sugarcane CCS value is reduced by the total costs at the actual and target values (after applying TE for inputs and labour). The total cost in question is the total cost before deducting the molasses revenue because smallholder sugarcane farming who choose the SPT partnership do not receive the molasses revenue share. Smallholder sugarcane farming who chose the SPT partnership did not experience a decrease in income. Therefore, the average income of the SPT partnership is currently IDR 2,690,984 and there is potential to increase the average income by IDR 4,630,446 to IDR 7,321,430 after efficiency measures are taken. The following is a more detailed presentation of smallholder sugarcane farming income in SBH and SPT partnerships in the Ngadiredjo Sugar Factory working area.

In this study, the feasibility of smallholder sugarcane farming is assessed based on the value of the RC ratio and BEP in each partnership scheme at actual and target values. In the SBH partnership scheme, the existing smallholder sugarcane farming (actual) in the working area of Ngadiredjo Sugar Factory has an RC ratio value of 1.18 (>1.00), so it is considered feasible. On the other hand, the value of the RC ratio if smallholder sugarcane farming performs TE, there is a possibility of increasing the RC Ratio from 0.08 to 1.26. The actual value of the BEP value of the farmer's sugar unit is 5,638 kg and is likely to be reduced after TE with an initial value of 350.79 kg to 5,288 kg. Likewise, the BEP Unit of sugarcane of smallholder sugarcane farming, at an actual value of 967.77 quintals and lowered after TE from a value of 60.20 quintals to 907.57

quintals. The BEP value of sugar price is IDR 11,180 per kg and is likely to be reduced from IDR 695.51 to IDR 10,485 per kg after TE. While the BEP CCS of 6.98% must be achieved by existing smallholder sugarcane farming (actual) although it has the potential to be reduced from 0.31% to 6.68% after TE.

Table 7.
Average Smallholder Sugarcane Farming Income by Partnership Scheme in Ngadiredjo Sugar Factory Working Area

No.	Component	Actual Value	Target Value	Difference	Unit
1	Productivity	1142.60	1142.60	-	Qu /Ha
2	**Profit Sharing System (SBH):**				
2.1.	CCS	7.87	7.87	-	%
2.2.	Sugar Price	13,200	13,200	-	IDR/Kg
2.3.	Sugar Production	8,997	8,997	-	Kg/Ha
2.4.	Sugar Amount for Farmers	6,657.66	6,657.66	-	Kg/Ha
2.5.	Total Revenue	87,881,059	87,881,059	-	IDR/Ha
2.6.	Income	13,446,543	18,076,989	4,630,446	IDR/Ha
3	**Sugarcane Purchasing System (SPT):**				
3.1.	Sugarcane Price	75,000	75,000	-	IDR/ Qu
3.2.	Sugarcane Revenue	85,695,000	85,695,000	-	IDR/Ha
3.3.	Sugarcane Revenue	2,690,984	7,321,430	4,630,446	IDR/Ha

Source: Primary Data Processed, 2023

In the SPT partnership scheme, the existing (actual) smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory shows an RC Ratio value of 1.03 (>1.00), so it can be said to be feasible. Likewise, with the value of the RC Ratio if smallholder sugarcane farming carries out TE, there is the potential to increase the value of the TE ratio by 0.06 to 1.09. The BEP value of the farmer's sugarcane unit at the actual value is 1,106.72 quintals and has the potential to be reduced to 1,044.98 quintals after making TE of 61.74 quintals. In addition, the BEP value of sugar price at the actual value of IDR 72,644 per quintal and has the potential to be reduced by IDR 4,052 per quintal to IDR 68,592 per quintal after TE.

The results of the feasibility of smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory show that the existing (actual) and target RC Ratio values after TE is carried out in the SBH partnership scheme show favourable results when compared to the SPT partnership. The implementation of the SBH partnership in 2023 has been carried out by all Sugar Factories of PT SGN including Ngadiredjo Sugar Factory, which in the previous milling year had implemented two SBH or SPT partnership options. However, some Ngadiredjo Sugar Factory partner farmers sometimes still send their sugarcane far away to Sugar Factories that apply the SPT partnership pole because the price of sugarcane has a higher profit and there is still residual sugarcane that is not milled at the partner sugar factory.

Ngadiredjo Sugar Factories working area has a very high demand in the sugarcane market because Kediri Regency consists of 2 (two) other Sugar Factories that are still in the same entity of PT SGN, namely Meritjan Sugar Factory and Pesantren Baru Sugar Factory. In addition, Rejoso Manis Indo (RMI) Sugar

Factory located in Blitar Regency is a competing private sugar factory that is still in the working area of Ngadiredjo Sugar Factory. The demand for sugarcane is also very high in brown sugar factories in addition to the demand in Ngadiredjo Sugar Factory. The total number of brown sugars MSMEs in Kediri Regency to date is ± 200 units. In Kediri District, there are also many sugarcane collecting units as many as 41 units. Sugarcane collecting units are commonly referred to as "pok-pokan". The potential income with various partnership schemes and the preparation of strategies to strengthen the partnership ecosystem with smallholder sugarcane farming needs to be known by Sugar Factory Pembina so that the potential income can be known. The principle is how efforts need to be made by sugarcane farmers to remain interested in growing sugarcane and have loyalty to their partner sugar factory. Below is a more detailed table of the feasibility of smallholder sugarcane farming according to the partnership scheme in the working area of Ngadiredjo Sugar Factory.

Table 8
Feasibility of Smallholder Sugarcane Farming by Partnership Scheme in Ngadiredjo Sugar Factory Working Area

No.	Component	Actual Value	Target Value	Difference	Unit
1	**Profit Sharing System (SBH)**				
1.1.	RC Ratio SBH	1.18	1.26	0.08	
1.2.	SBH Sugar Unit BEP	5,638	5,288	-350.79	Kg/Ha
1.3.	BEP Sugar Price SBH	11,180	10,485	-695.51	IDR/Kg
1.4.	BEP Sugarcane Unit SBH	967.77	907,57	-60.20	Qu/Ha
1.5.	BEP CCS	6.98	6.68	-0.31	%
2	**Sugarcane Purchasing System (SPT)**				
2.1.	RC Ratio SPT	1.03	1,09	0,06	
2.2.	BEP Unit Sugarcane SPT	1,106	1,044	-61.74	Qu/Ha
2.3.	BEP Sugarcane Price SPT	72,644	68,592	-4,052.55	IDR/ Qu

Source: Primary Data Processed, 2023

CONCLUSION AND SUGGESTION

1. CONCLUSION

The average Technical Efficiency (TE) score in the Ngadiredjo Sugar Factory working area is 0.91 (91%) which means that smallholder sugarcane farming in the Ngadiredjo Sugar Factory working area can increase the average by 9% by reducing the use of production inputs. Factors that have a positive effect on TE in the Ngadiredjo Sugar Factory working area are D1 (Dummy variable for role of Sugar factory.

The average actual income of smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory in the PC crop category is still profitable. In the SBH partnership scheme, the existing (actual) smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory has an RC ratio value of 1.18 (>1.00), so it is considered feasible. In the SPT partnership scheme, the existing (actual) smallholder sugarcane farming in the working area of Ngadiredjo Sugar Factory shows an RC Ratio value of 1.03 (>1.00), so it can be said to be feasible. Likewise, with the value of RC Ratio if smallholder sugarcane farming does TE, there is a potential increase in the value of TE ratio of 0.06 to 1.09. So, when considering the value of income and RC ratio as well as smallholder sugarcane

farming assumptions in this study, it shows that the SBH partnership scheme is better than the SPT partnership scheme.

2. ADVICE

The potential for increasing TE in the Ngadiredjo Sugar Factory's work area can be achieved through a strategy of strengthening the sustainable partnership ecosystem by strengthening smallholder sugarcane farming with all relevant stakeholders, not just the Sugar Factory, such as Financial Institutions (KUD/KPTR/Banking), APTR (Regional Agricultural Excise Agency), and the Ministry of Agriculture to encourage farmer interest in growing sugarcane and loyalty to Sugar Factory partners.

Efforts are needed to strengthen the small-scale sugarcane farming intensification program to encourage increased sugarcane and sugarcane productivity and agricultural income through assistance with sugarcane cultivation in accordance with Good Agricultural Practices (GAP), namely: (1) variety management; (2) healthy seeds; (3) sugarcane cultivation in accordance with GAP; (4) pest control; (5) management of cut cargo transportation in accordance with MBS (sweet, clean, and fresh) criteria; and (6) increasing the efficiency of Sugar Factory performance.

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