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Technical Efficiency Of Sugar Cane Farming In PT PG Rajawali II Unit PG Sindanglaut

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Abstract. This research aims to determine the profitability and technical efficiency of sugarcane farming in PG Sindang Laut, Cirebon Regency, West Java. The research method used was survey research with 60 respondents of 30 plant cane and 30 ratoon cane. The data analysis used includes (1) descriptive analysis, (2) Cobb-Douglas production function with the SFA approach using Frontier 4.1, and (3) income analysis. The results of this research showed that land area, seeds, phonska fertilizer, and labor affect sugar cane production in the plant cane category. On the other hand, land area, seeds, phonska fertilizer, and ZA fertilizer affect the technical efficiency of sugar cane farming of ratoon cane category. The factors that influence technical efficiency in the plant cane category are age, farming experience, and family responsibility. While education and farming experience influence technical efficiency in the ratoon cane category. The average income from sugarcane farming in the plant cane and ratoon cane categories is IDR 6,183,019/ha and IDR 13,005,430/ha.

Keyword: income, plant cane, ratoon cane, sugarcane farming**,** technical efficiency

INTRODUCTION

Sugar cane *(Saccharum officinarum L*) is one of the plantation crops in Indonesia which has been cultivated for 500 years with specialization, intensification, and on a large scale. Sugar cane is a sugar-producing plant, where sugar is one of the staple food ingredients in Indonesia. Sugar demand in Indonesia is around 7.9 million tons, increasing every year since 2017 (Kurniasari et al. 2015 and Ramadani et al. 2024). In 2022, the planting area will be recorded at 15,529 ha with an average productivity of 67.44 tonnes/ha (Kementerian Pertanian, 2022). This is what strengthens sugarcane as a strategic commodity with the potential to be developed. West Java Province is one of the sugar cane production areas managed by the state under the company PT PG Rajawali II in Cirebon, one of which units is PG Sindang Laut. Sugarcane productivity in West Java when compared with sugarcane

productivity in the provinces of East Java and Sumatra is still relatively low. Farmers in East Java have a better level of willingness and ability to carry out sugarcane farming. Productivity is the ability of a plant to produce production per certain unit of land. High or low production is determined by the amount of production input used such as the amount of land used, fertilizer used, and other inputs used for farming (Wijaya et al., 2023)

Sugarcane has high economic value as a raw material for sugar because sugar is a staple food that has an important role in meeting people's basic needs, contributing to the economy, and having a big impact on national food security. Sugar production in 2019 was only 2.46 million tonnes from a harvested area of approximately 448,400 Ha, which means the average productivity was only approximately 5.46 tonnes of sugar/Ha. One of the causes of low sugar production is the relatively low level of sugar cane productivity, far below the potential of the variety. The average national sugar productivity in the last 10 years is no more than 6 tons of sugar/Ha (Badan Pusat Statistik, 2023) even though the varieties used can generally reach 10 tons of sugar/Ha or even more.

Table 1. Land area, production, and productivity of sugarcane in PG Sindanglaut 2019-2023

Years	Land Area (ha)	Rate (%)	Production (ton)	Rate (%)	Productivity (ton/ha)	Rate (%)
2019	2,850.34	-	143,702	-	50,4	-
2020	2,179.50	-23.54	145,652	1.36	66,8	32.54
2021	2,243.52	2.94	127,034	-12.78	56,6	-15.27
2022	2,523.40	12.48	181,749	43.07	72,0	27.21
2023	2,899.69	14.91	145,737	-19.81	50,3	-30.14
Mean	2,539.29	1.70	148,775	2.96	59.22	3.58

Source: PG Production Sector PG Sindanglaut (2023)

The sugarcane land area has expanded by an average of 1.7% in 2019-2023. In 2020 land area decreased by 23.54%. Meanwhile, in 2021 and 2023, production rates and productivity decreased by 12.78% and 19.81%. This is expected to be because most farmers experience crop failure due to weather factors. The average production and productivity is 2.96% and 3.58% per year.

The level of production is influenced by the amount of production input used, such as land area, seeds, types of fertilizer, medicines, and labor to support sugar cane growth. It is hoped that wider land use and the quantity of fertilizer provided will increase sugar cane production. Efficiency in farming is not only based on the inputs entered by farmers, social factors or external factors can also influence efficiency. Inefficiency factors include age, education level, farming experience, and number of family dependents. If the inefficiency

value is high, it means that the level of farmer efficiency in their farming business is reduced. According to Machmuddin (2019), inefficient use of production inputs can be influenced by external factors. Therefore, it is necessary to further identify which factors will influence efficiency and inefficiency.

Sugarcane production and productivity are still low, allegedly because farmers are not efficient in using production inputs which will affect technical efficiency, including land area, seeds, use of ZA fertilizer, Phonska fertilizer, herbicides, and labor. Efficiency is also related to farmer income, if farmers have reached an efficient level then their income will increase. Based on the description above, it is necessary to conduct a study regarding the technical efficiency of sugarcane farming so that the objectives of this research can be obtained, namely: 1) Descriptive analysis; 2) Cobb-Douglas Production Function with the SFA approach using Frontier 4.1; 3) Income analysis.

LITERATURE

Sugarcane is a plant that is harvested through the stem to extract sugar. Sugarcane plants are divided into the categories of plant cane and ratoon cane, which have different productivity results. Plant cane can be said to be the initial cultivation using new sugarcane seeds, after harvesting it will become ratoon cane or it can be called kepras sugarcane so that it will reduce the seedlings in its cultivation. (Fanny, 2019).

Farming science studies how someone cultivates and manages production factors in the form of land and the natural surroundings as capital to maximize benefits. Farming science is a science that studies farmers' ways of managing the effective and efficient use of production factors to obtain maximum income (Suratiyah, 2015). According to Sadono (2010), the production function shows the nature of the relationship between production factors and the level of production produced. The factors of production are known as input and the amount of production or output. The production function is expressed in the following formula: Q = f (K, L, R, T) Where K is the amount of capital stock, L is labor, R is natural wealth and T is the level of technology used. Meanwhile, Q is the amount of production produced by various types of production factors. Simultaneously used to produce goods whose production properties are being analyzed. The efficiency concept used in this research refers to the efficiency proposed by Coelli et al. (1998). Technical efficiency (TE) is the ability of a company (farming) to obtain maximum output from the use of an input. Technical efficiency relates to a company's ability to produce on the frontier isoquant curve.

Inefficiency in farming will be followed by low productivity. The inefficiency factor is caused by two factors, namely internal factors and external factors. Internal factors are socio-economic conditions that influence farmers' managerial abilities such as education, age, experience, etc. Meanwhile, external factors are things that are beyond the farmer's control, such as natural disasters, climate, disease, pests, and so on. The results obtained from sources of inefficiency show that the variables that significantly influence technical inefficiency are the farmer's age, highest level of education, farming experience, and number of family members (Sumaryanto, 2001). Several studies on efficiency were conducted by researchers in Indonesia and abroad. Technical efficiency research was carried out on rice, cassava, potatoes, rubber, and even sugar cane commodities. research conducted by (Jimi et al. 2019, Rabbany et al. 2022, Missiame et al. 2021, Taubadel and Saldias 2014) the results of the research show that technical efficiency is influenced by various factors including financing.

Research on the efficiency analysis of plant cane and ratoon cane has been conducted in several areas, for example in PTPN X by Setyawati (2019). The production inputs used are land area, sugarcane seeds, ZA fertilizer, phonska fertilizer, pesticides, and labor. Significant efficiency results obtained for the plant cane category were land and ZA fertilizer, while in the ratoon cane crop category, significant results were obtained from land, phonska fertilizer, and pesticide inputs.

Another study researches the efficiency based on the plant cane and ratoon cane categories in the North Lampung region by involving production inputs of land area, seeds, urea fertilizer, KCl fertilizer, TSP fertilizer, herbicides, and labor. Significant results occurred in the inputs of land area, labor, KCl fertilizer, and herbicides for both plant cane and ratoon cane categories (Astuti et al., 2021).

A study on technical efficiency for the plant cane and ratoon cane categories also occurred in Malang Regency by Rizkiyah (2018) using inputs of seeds, ZA fertilizer, phonska fertilizer, organic fertilizer, embroidery seeds, and labor. ZA fertilizer, phonska fertilizer, and labor had a significant effect on the two categories while for RC, there were other significant inputs, including organic fertilizer, embroidery seeds, and labor.

Revenue is income earned within a certain period. Any earnings received from the sale of products and services produced inside the business unit is referred to as revenue. Farming income is some costs incurred in a farming business, known by using the relation

between overall costs and production results in a single production process (Ramadhani, 2023).

Several studies on the analysis of sugarcane farming income conducted by Yuliandari (2024), Agustin (2024), and Astuti (2021) stated the results showed that there were differences between the plant cane and ratoon cane systems, where the ratoon cane system generated higher income than the plant cane category.

METHOD

This research was conducted on the fostered farmers of PT. PG Rajawali II Unit PG Sindanglaut which is one of the largest state-owned companies that produce sugar in the Eastern Cirebon Regency area. The research time is in May-June 2024 with the object of field study of PT. PG Rajawali II Unit PG Sindanglaut. The research method used in this research is descriptive quantitative with a survey approach. The sample size used is based on Rocoe's book Research Methods for Business (1982) regarding sample size for research, namely if the sample is divided into categories then the number of samples for each category is at least 30 (Sugiyono, 2018). The sample in this study consisted of 60 respondents with 30 plant cane farmers and 30 ratoon cane farmers. Plant cane farmers plant sugar cane from the start, starting from seeding, while ratoon cane farmers plant sugar cane without planting it from the beginning. Respondent farmers in the ratoon cane category at TRS II planting.

Primary data was obtained through interviews using questionnaires and secondary data was obtained from the Central Statistics Agency (BPS), West Java Plantation Service, PT. PG Rajawali II Unit PG Sindanglaut. Data on the characteristics of respondent farmers and farming businesses were analyzed descriptively. To determine Technical Efficiency, the Cobb-Douglas Production Function with the SFA approach is used. The stochastic frontier production function of sugar cane farming can be estimated mathematically by entering six independent variables into the frontier equation as follows (Coelli et al., 1998).

$$Ln\ Y = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + (v_i - u_i)$$

Where :

Y = Sugarcane Production (ku)

X_1 = Land Area (m^2)

X_2 = Seeds (kg)

X_3 = Ponska Fertilizer (kg)

X_4 = ZA Fertilizer (kg)

X_5 = Herbicide (liter)

X_6 = Labor (HOK)

β_0 = Intersep

β_I = Regression Coefficient

V_i = error term

U_i = The Effect of Inefficiency

The sign and magnitude of the expected parameter $\beta_{I,}\beta_{2,}\beta_{3,}\beta_{4,}\beta_{5,}\beta_6 > 0$

Technical efficiency analysis was carried out using a stochastic frontier model using the following formula (Coellie et al., 1998)

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

$$= expexp\ (-u)\ I = 1, 2, 3, \ldots n$$

Where TE = Technical Efficiency

Yi = actual output of Observation

Y*= Frontier output *frontier* from *stochastic frontier production*

TE is the farmer's technical efficiency which ranges from $0 \leq TE \leq 1$, this value is inversely influenced by the technical efficiency value and is used for functions that have a certain amount of output and input. The efficiency of using production factors in sugar cane farming generally has not/does not reach the efficient category, meaning that there are factors causing inefficiency that can come from outside or from within the farmer. Farmers have tried to control factors, for example, by providing irrigation, building wells to overcome water shortages, and using herbicides to control weeds. Therefore, in this research, the factors causing inefficiency are age, highest level of education, farming experience, and number of family dependents. Factors influencing the technical efficiency of sugarcane farming were analyzed using SPSS Statistics Version 27, namely through Multiple Linear Regression Analysis. The equation used to see the factors that influence the level of technical efficiency of people's sugarcane farming is as follows

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$$

Where :

Y = Sugarcane technical efficiency

b_0 = Reggresion Coefficient

X_1 = Age (Years)

X_2 = Education (years)

X_3 = Farming experience (years)

X_4 = Number of family (people)

To analyze the income of sugarcane and ratoon cane farmers, it's formulated as follows (Soekartawi, 2016).

a) Total Cost

Total costs are the total amount of production costs incurred from the sum of fixed costs and variable costs

$$TC = TFC + TVC$$

Where:

TC = Total Cost

FC = Total Fixed Cost

VC = Total Variable Cost

b) Revenue the amount of farming income can be determined using the formula:

$$TR = P \times Q$$

Where:

TR = Total Revenue

P = Price

Q = Quantity Production

c) Income

The amount of income that can be obtained from the resulting production can be determined by the formula:

$$\pi = TR - TC$$

Where :

π = Income

TR = Total revenue

TC = Total cost

d) R/C Ratio

$$\text{R/C Ratio} = \frac{TR}{TC}$$

Where :

TR = Total Revenue

TC = Total Cost

If the result of R/C < 1, then the business carried out economically can be said to be inefficient and not profitable. R/C > 1, then the business carried out economically can be

said to be efficient and profitable. Meanwhile, if R/C = 1, then the business activity has no profits or losses.

DISCUSSION

Descriptive Analysis

The characteristics of the sample farmers are an important factor in researching farming because by knowing the characteristics of the sample farmers, you can get a general picture of the situation and background of the sample farmers. Characteristics of sample farmers in this study include age, highest level of education, farming experience, number of family dependents, and land area. Characteristics of sugar cane farmers at PT. PG Rajawali II PG Sindanglaut Unit is presented in Table 2.

Table 2. Farmers Characteristic

No	Characteristics of sugar cane farmers	Category	Plant Cane (PC)		Ratoon Cane (RC)	
			amount (people)	Rate (%)	amount (people)	Rate (%)
1.	Age (year)	31-40	8	26.67	10	33.33
		41-50	11	36.66	10	33.33
		51-60	8	26.67	8	26.67
		>61	3	10	2	6.67
2.	Education (year)	SD	12	40	14	46.67
		SMP	6	20	3	10
		SMA	8	26.67	6	20
		S1	4	13.33	7	23.33
3.	Experience (year)	1-10	19	63.33	12	40
		11-20	11	36.67	17	56.67
		21-30	0	0	1	3.33
4.	Family Responsibility (people)	1-3	22	73.34	23	76.67
		4-6	7	23.33	6	20
		>7	1	3.33	1	3.33
5.	Land Area (Ha)	1-10	30	100	25	83.34
		11-20			4	13.33
		>20			1	3.33

Source: Primary Data, 2024 (Processed)

Based on Table 2, the age of respondent farmers in the plant cane category with the highest percentage of 36.66% is in the range of 41-50 years with an average age of 46 years. In the ratoon cane category, the age of farmers in the range of 31-40 and 41-50 has the same percentage of 33.33% with an average farmer age of 45 years. This shows that respondents are in the productive age category, farmers with a productive age will find it easier and faster to accept innovation. Conversely, farmers at a non-productive age will tend to find it difficult to accept innovations. The younger farmers usually have the spirit to want to know what they don't know, so they try to adopt innovations faster (Soekartawi, 2016).

The education level of sugarcane farmers is low because the highest percentage is in the elementary category. The adoption of agricultural improvements and the application of technology are directly correlated with level of education. The higher the education of farmers, the easier it is for farmers to understand and accept technological changes or innovations in agriculture (Zainuddin & Wibowo, 2019).

Farmers' experience in farming is one of the factors that influence their success in running their farms. In the plant cane category, the most experienced of farmers is in the range of 1-10 years with a percentage of 63.33% while the highest percentage of ratoon cane category farmers is in the range of 11-20 years with a percentage of 56.67%. The average experience of plant cane and ratoon cane sugarcane farmers is 8 and 11 years. Most farmers have been running sugarcane farms since they were young and sugarcane is a hereditary commodity. There is a tendency that the longer the experience of farmers about sugarcane farming, the better and worse the farming is done, and the more skillful in conducting farming and choosing the technology to be used.

The number of family dependents of farmers is mostly in the range of 1-3 people with a percentage of 73.34% as many as 22 people in the plant cane category and 23 people with a percentage of 76.67% in the ratoon cane category. According to Indra et al (2012), the number of family dependents affects the responsibility of farmers to meet family needs. When the number of family dependents is large, farmers will try their maximum ability to meet family needs. The size of family dependents also affects farmers' attitudes toward the application of new technology in the agricultural system.

Farmers in the plant cane category have a land area of less than 10 hectares while in the ratoon cane category, only 83.34% of farmers have a land area of less than 10 hectares and 16.33% more than 10 hectares. According to Mardikanto (1993), farmers with large paddy fields will obtain large production yields and vice versa.

Factors Affecting Sugarcane Production

Technical efficiency analysis using Frontier 4.1 Software can determine the factors that influence sugar cane production. The sugarcane production factors analyzed in this research include land area, seeds, phonska fertilizer, ZA fertilizer, herbicides and labor. Results of estimation of the stochastic frontier production function of sugar cane farming in the plant cane and ratoon cane categories at PT. P.G. Rajawali II Unit PG. Sindanglaut is presented in Table 3.

Table 3. Factors Affecting Sugarcane Production

Variable	*Plant Cane* (PC)		*Ratoon Cane* (RC)	
	Coefficients	t-ratio	Coefficients	t-ratio
beta 0	-2.2991	-3.1268	-1.7806	-2.1531
beta 1 (Land Area)	-0.0012	-7.8392***	-0.0011	-10.2289***
beta 2 (Seeds)	1.8670	3.5086***	0.9411	9.4470***
beta 3 (Phonska)	0.0016	2.9019***	0.0008	5.9944***
beta 4 (ZA)	-0.6205	-1.3550	0.0525	3.4916***
beta 5 (Herbicide)	-0.0005	-1.4291	-0.00006	-0.4237
beta 6 (Labor)	-0.3643	-5.0585***	-0.0614	-1.1242
Sigma-squared	0.2334	9.7111	0.1106	7.2159
gamma	0.9999	496145.2	0.9973	383.883

Note : *** sign at α 0,01, ** sign at α 0,05, * sign at α 0,1

Source: Primary Data, 2024 (processed)

Based on Table 3, the value of the sigma-squared coefficient on plant cane and ratoon cane criteria amounted to 0.23 and 0.11. The value is relatively low or close to zero, which indicates that the error-term inefficiency in sugarcane farming in the research location is normally distributed. The second gamma value is 0.99, which means that 99% of the error in the stochastic frontier production function is caused by technical inefficiency.

The estimation results show that land area has a significant and negative effect on both categories with an alpha level of 1%, each t-ratio obtained 7.83 for the plant cane category and 10.22 for the ratoon cane category. This means that a one percent increase in land area will reduce sugarcane production by 0,0012 Ku for plant cane land and 0.11 Ku for ratoon cane land with other factors considered constant. The land area is significant but has a negative value is thought to be because the larger the land being cultivated, the more difficult it is for labor to reach and ensure which side of the land has been managed or not. The ideal land area for sugarcane farming in the Sindanglaut area is 2-3 ha.

The use of seeds and phonska fertilizer in plant cane has a significant effect at a 1% alpha level and is positive. When the usage of seeds increases by 1 kg, it will increase sugarcane production by 1.86 Ku, while a 1 kg increase in phonska can increase production by 0.0016 Ku with other factors considered constant. This statement is relevant to the research conducted by Carani (2024) and Setyawati (2019).

In the ratoon cane category, the variables of seedlings, phonska fertilizer, and ZA fertilizer had a significant effect at the 1% alpha level and were positive on sugarcane production. The t-ratio values were 9.44 for seedlings, 5.99 for phonska fertilizer, and 3.49 for ZA fertilizer. This shows that the addition of these inputs by 1 kg will increase production by 0.94 Ku from the increase in seeds which is in line with the research of Fitriani (2023)

and Anggraini (2016), an increase in phonska fertilizer by 1 kg will increase sugarcane production by 0.08 Ku which is in accordance with research by Fatikhin & Sudjoni (2020), and the addition of 1 kg of ZA fertilizer will increase sugarcane production by 5.25 Ku which is in line with research by Rizkiyah (2018).

The labor variable in plant cane has a significant effect but the value is negative to production at the 1% level with a t-ratio value of -5.058. This means that an increase in labor input by 1 HOK will reduce sugarcane production by 0.36 Ku. This is in line with research by Lestari et al. (2019).

The use of herbicides has a non-significant effect on sugarcane production in the plant cane and ratoon cane categories because $t_{ratio} < t_{table}$ is (-0,0005 < 2,81) dan (-0.00006 < 2,81). The results of this study are in line with research by Manurung et al (2018) which states that the use of herbicides is positive and does not have a significant effect on sugarcane production.

Technically, farmers who conduct farming are called efficient if they have a technical efficiency value ≥ 0.7 (Darmawan, 2016). The distribution of technical efficiency of people's sugar cane farming criteria for plant cane and ratoon cane PG Sindanglaut can be seen in Table 4.

Table 4. Technical efficiency distribution

Technical efficiency	***Plant Cane* (PC)**		***Ratoon Cane* (RC)**	
	amount (people)	**Rate (%)**	**amount (people)**	**Rate (%)**
< 0,7000	11	36.67	7	23.33
>0,7000	19	63.33	23	76.67
Total	30	100	30	30
Average	0.719		0.775	
Min	0.228		0.395	
Max	0.999		0.990	

Source: Primary Data, 2024 (Processed)

Based on Table 4, 36.67% and 23.33% of sugar cane farmers in the plant cane and ratoon cane categories are in the inefficient category. 63.33% and 76.67% of sugarcane farmers in the plant cane and ratoon cane categories are in the efficient category because farmers are optimal in using production inputs. The average technical efficiency of ratoon cane farming is greater than the plant cane criteria, which is 77%, while plant cane sugarcane farming only reaches 71%. This indicates that ratoon cane farming is more technically efficient than plant cane sugar farming.

The level of technical efficiency achieved can be influenced by the farmer's managerial ability in running his farming business. Farmers' managerial abilities are related to the characteristics of the farmers themselves. Farmer characteristics that are thought to influence technical efficiency are age, experience, highest level of education, and family members. The results of the determination of the calculation of Stochastic Frontier Analysis (SFA) estimate in the form of technical efficiency were analyzed using SPSS software Multiple Linear Regression to factors affecting the technical efficiency of sugarcane farming. From the observed data, the regression equation was obtained as follows:

Plant cane Category

$$Y = – 0{,}080 + 0{,}008\ X1 + 0{,}008X2 + 0{,}022X3 + 0{,}056X4$$

Ratoon cane Category

$$Y = 0{,}444 + 0{,}004X1 + 0{,}016\ X2 + 0{,}011X3 – 0{,}030X4$$

Table 5. Factors Affecting Technical Efficiency

Variable	Plant Cane (PC)			Ratoon Cane (RC)		
	Coefficients	T-value	p-value	Coefficients	T-value	p-value
Constant	-0.080	0.478	0.637	0.444	4.095	0.001
Age (X1)	0.008	2.746	0.011	0.004	1.611	0.120
Education (X2)	0.008	0.878	0.388	0.016	2.943	0.007
Experience (X3)	0.022	3.041	0.005	0.011	2.184	0.039
Family Responsibility (X4)	0.056	2.132	0.043	-0.030	-1.378	0.180
R^2	0.646			0.400		
F	14.210			5.839		
Sig F	0.001			0.002		

Source: Primary Data, 2024 (processed data)

The coefficient of determination (R^2) is 0.646 in plant cane and 0.400 in ratoon cane. This shows that the independent variables can explain the dependent variable of plant cane by 64.6%, while the remaining 35.4% is explained by other variables. While the ratoon cane shows the influence of variables on sugarcane efficiency at 40%, the remaining 60% is influenced by other variables.

The F_{test} value shows the independent variable's simultaneous impact on the dependent and the provisions of F_{test} (14.210) > F_{table} (2.60) for plant cane and F_{test} (5.839) > F_{table} (2.60) for ratoon cane, then the independent variable influences the dependent variable.

The value of T_{value} shows the effect of each independent variable on the dependent variable with the provision of T_{value} > T_{table} (2.060). So the independent variables of age, experience, and family dependents for plant cane influence technical efficiency. For ratoon cane, education level and experience affect technical efficiency.

The regression analysis above was obtained in the form of factors that influence technical efficiency. The age variable has a positive coefficient with a p-value of 0.011. This value is smaller than 0.05, which means that age has a positive and significant effect of 5% on the technical efficiency of sugarcane farming. This means that every additional 1 year of age will increase the level of technical efficiency by 0.008. The age of farmers is limited by the research data, namely a minimum of 22 years old and a maximum of 71 years old because the age of farmers under 71 can increase technical efficiency and reduce technical inefficiency while the age of farmers over 71 years will increase the technical inefficiency of sugarcane farming because of the reduced labor of farmers. These results are following research by Kartika Setyawati & Wibowo (2019) and Permadhi & Dianpratiwi (2021).

The level of education affects technical efficiency in the cane ratoon category and the number of family dependents affects the technical efficiency of the cane plant category. This can be understood because the higher the level of education, the higher the level of technical efficiency (Astuti et al., 2021). The number of family dependents has a p-value of 0.043, still below 0.05, meaning that the greater the number of family members will increase technical efficiency and reduce the level of inefficiency or the same. When the number of family dependents is large, farmers will try their best to fulfil their family needs.

On the farming experience variable, the results were found to have a significant effect and had a positive value at a p-value of 0.005 for plant cane and 0.03 for ratoon cane. It means that the longer a farmer has experience in carrying out sugarcane farming, the higher the level of efficiency or the same as reducing the level of inefficiency. The longer the farming experience, the conclusion it can be drawn that the farmer already understands and masters cultivation techniques in his farming activities. According to Carani (2024), the longer the farming experience, the more agile the farmer will be in making rational decisions for the farming business he is running. The results of this research are in line with research by Kartika & Wibowo (2019) and Carani et al., (2024).

Analysis of Sugarcane Farming Income

The production facilities used by respondent farmers to cultivate sugar cane are land, seeds, phonska fertilizer, ZA fertilizer, herbicides, and labor. The use of sugar cane seeds is only needed for the initial criteria for planting sugar cane or plant cane, while the need for seeds for ratoon cane are only needed for farmers who replant if a plant does not grow well as a type of ratoon plant. The seed varieties used by respondent farmers are PSJT 941 and

BL types. PG assisted in procuring the seeds. Sindanglaut at a price of IDR 900.000 per ton of sugar cane.

Respondent farmers at the research location use 2 types of fertilizer, namely Phonska fertilizer and ZA fertilizer. Farmers use phonska fertilizer which can be obtained from farmer cooperatives and shops that sell sugar at IDR 230.000/Ku, while ZA fertilizer is provided from factories at a price of around IDR 440.000/Ku.

Generally, respondent farmers use 2-3 types of herbicides. The attack by weeds, rayutan, and sedge grass in sugar cane fields is quite high intensity. So, the respondent farmers carried out weed control twice. Meanwhile, pest control is rarely carried out by respondent farmers, because the intensity of pest attacks is still below the control threshold, so it does not significantly affect sugar cane production.

Respondent farmers at the research location use labor to carry out sugarcane farming activities. The wages paid by respondent farmers are Rp. 70,000 for men and IDR 45,000 for women. Apart from that, respondent farmers in the research location also use mechanization, namely tractors for land processing, digging and hilling. Analysis of sugarcane farming income at PT. P.G. Rajawali II Unit PG. Sindanglaut can be seen in Table 6 below.

Table 6. Income Analysis Sugarcane Farming

No.	Description	unit	Plant Cane		Ratoon Cane	
			amount	Value (Rp)	amount	value (Rp)
1.	Cost					
	A. Fixed Cost					
	Land rent	Ha	1	7,000,000	1	7,000,000
	Mechanization	Rp		2,891,582		950,000
	Asosiation PTR FMPG	Rp		85		85
	Bag & Assurance	Rp		310,353		273,493
	Office Stationery	Rp		12,279		10,820
	Fee KUD & group	Rp		230,223		202,881
	Milling safety cost	Rp		153,719		147,339
	Fee bank	Rp		2,385,984		1,674,868
	Amount	Rp		12,984,225		10,037,883
	B. Variable Cost					
	Seeds	Ton	8	7,200,000	1,28	1,152,000
	Ponska fertilizer	Ku	6	1,380,000	6	1,380,000
	Za fertilizer	Ku	5	2,200,000	5	2,200,000
	Herbicide	Liter	10	1,138,977	9.32	1,015,247
	labor	HOK	118	6,761,469	105	5,232,183
	Pump	Rp		151,288		79,583
	Hall of	Rp		10,336,423		8,270,834
	Amount	Rp		29,168,157		19,329,847
	Total cost (A+B)			42,152,382		29,589,333
2.	Revenue					
	Sugar Production (90%)	Ku	34.19	41,025,808	30.13	36,153,307

	Sugar Production (10%)	Ku	3.80	4,558,423	3.35	4,017,034
	Drip production	Ku	23.02	5,295,138	20.29	4,666,252
	Total Revenue	Rp		50,879,369		44,836,593
	PPH 5%	Rp		2,543,968		2,241,830
3.	Income	Rp		6,183,019		13,005,430
4.	R/C			1.207		1.515

Source: Primary Data, 2024 (processed data)

Based on Table 6, the highest income from sugar cane farming in the Sindanglaut sugar factory area for the respondents studied was in plant cane category. The level of income received by farmers is influenced by the results of sugar cane production and yield. The production of sugarcane at the early planting criteria is higher than that of the ratoon category because the quality is still high and will experience a degradation when it becomes ratoon cane.

From the research results, the highest sugar cane revenue occurred in the early crop type with an average of IDR 50.879.369/ha because the quality of the seeds was still new, which means it had not experienced any decline. The production costs incurred for initial planting are also higher than for hard cane because there are large-scale costs for clearing land and planting seeds in the cultivation costs. So there is a suspicion that the production costs are greater than the revenue obtained.

In contrast to the plant cane type, ratoon sugar cane plants do not require many seeds so production costs can be reduced from the initial planting type of production. Even though the revenue obtained is lower, the production costs are much lower than plant cane plants. This shows a difference between the plant cane and ratoon cane systems, with the ratoon cane system producing higher income than the plant cane system (Yuliandari et al., 2024).

Based on the results of the analysis, the R/C Ratio for plant cane farming was 1.207 (>1) and the R/C Ratio for ratoon cane farming was 1.515 (>1). This means that every additional fee of IDR 1,000 will provide additional revenue of IDR 1,207 for plant cane and IDR 1,515 for ratoon cane. Thus, both generate profits and are worth the effort. The feasibility of ratoon cane farming produces higher value due to lower production costs compared to plant cane.

CONCLUSION

In the plant cane category, the average age of respondents is 46 years old, with the largest percentage at 36.66%, meanwhile in the ratoon cane category, the average age of respondents is 45 years old. Experience of farmers in the plant cane and ratoon cane

categories has a percentage of 63.33% and 56.67% with an average experience of 8 and 11 years. The number of family dependents of farmers is in the range of 1-3 people. Farmers in the plant cane category have a land area of less than equal to 10 hectares, while in the ratoon cane category, there are 83.34% of farmers with less than 10 hectares of land and 16.33% of farmers have a land area of more than 10 hectares.

The results of the analysis of factors affecting the technical efficiency of sugarcane plant cane farming include land area, seeds, phonska fertilizer, and labor, and factors affecting inefficiency are age, farming experience, and the number of family dependents. In the ratoon cane category, factors that influence technical efficiency are land area, seeds, phonska fertilizer, and ZA fertilizer as well as factors that influence inefficiency, namely level of education and experience. The plant cane type obtained an average of 71% while the ratoon cane type obtained an average efficiency of 77%. This shows that ratoon cane is more technically efficient.

There is a difference in revenue between PC and RC sugarcane criteria where the average revenue per ha for PC sugarcane farming is greater than RC. However, the net income obtained for RC sugarcane farming is higher due to lower production costs and higher sugarcane yields. So the total income from sugarcane farming for PC and RC criteria in the PG Sindanglaut area is IDR 6,183,019 and IDR 13,005,430 per ha.

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