

The Effect of Land Area, Yield, and Milling Capacity on Sugar Production In PT Perkebunan Nusantara (PTPN) XI

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ABSTRACT

This research has been carried out at PT. Perkebunan Nusantara XI aims to evaluate the influence of some factors, such as land area, yield, and milling capacity, on sugar production at PT. Perkebunan Nusantara XI. This study uses secondary data in the form of quantitative data from production records belonging to PTPN XI from 2011 to 2020. The data obtained were then analyzed statistically using multiple linear regression. The simultaneous effect of the three variables on sugar production has been analyzed using the F test. In contrast, the partial effect of each variable has been analyzed using the t-test. The statistical analysis results showed that the three variables, land area, yield, and milling capacity, had a positive and significant simultaneous effect ($P < 0.05$) on sugar production. The results of the partial analysis showed that land area had a positive and significant effect ($P < 0.05$) on sugar production, but yield and milling capacity had no significant effect ($P > 0.05$) on sugar production. Based on the results of multiple linear regression analysis showed that land area and yield had a significant effect ($P < 0.05$) on sugar production. In contrast, milling capacity had no significant effect ($P > 0.05$) on sugar production. The equation of the multiple linear regression lines between land area, yield and milling capacity on sugar production is as follows: $= -59.038 + 3.860 X1 + 3.860 X2 - 0.799 X3 + 0.05$. The conclusion is that land area, yield, and milling capacity simultaneously affect sugar production, while yield, and milling capacity partially does not affect sugar production.

Keywords: Sugarcane Production; Land Area; Yield; Capacity Grind.

INTRODUCTION

Sugar is a simple carbohydrate, a significant energy source, and a trade commodity. The main ingredient of sugar that is often used in Indonesia is sugar cane because this grass-type plant mainly grows in tropical climates, which is suitable for the climate in various regions in Indonesia. In addition, sugarcane is one of the essential seasonal crop plantation commodities in developing the plantation sub-sector. This is partly to meet the needs of domestic and exported sugar to increase sugarcane production and productivity and to support the success of the National Sugar Self-Sufficiency Program. In the East Java area, the National Sugar Productivity Improvement Acceleration program has been implemented since 2001 to help realize existing programs [1].

The development of the sugar industry in Indonesia plays an essential role for the community because sugar is a basic need for the community and has a crucial role in the industrial sector [12]. The increasing consumer demand for sugar, the more excellent the opportunity for companies to produce sugar, even requiring sugar companies to produce sugar optimally. However, in reality, the sugar industry often experiences fluctuations in sugar production. Even though, to meet these needs, sugar production must be more than its consumption, which is in line with the increase in the community's population [8].

The sugar factory is an agro-industrial system that is a downstream sector, so it must be firm with the upstream sector, become a strong multiplier effect in an area, capital and labor intensive. Therefore, the right policy is decisive in its development [5].

The condition of the sugar agroindustry has fluctuated in recent years. Productivity increases tend to be slow, far behind production costs. The sugar agroindustry has faced the fact that its profitability is only obtained from agro-climatological support because sugarcane prices are influenced by agro-climatology. Factors influencing the decline in sugar production include capital, technology, raw materials, finished product, land area, yield, sugarcane varieties, milling capacity, and profit-sharing system. A sufficient supply of raw materials affects the production system and the final product, ensuring a successful marketing process and customer satisfaction. The unavailability of goods makes it difficult for suppliers to dominate the market and reduce delivery effectiveness [13].

Several ways to anticipate the decline in sugar production, such as increasing the power and efficiency of each factory station, determining the yield in each factory and also, and increasing collaboration between departments of the sugar factory and the need to apply the Sweet, Clean, Fresh (SCF) standard. There is a significant increase in sugar production due to improvements in machinery, equipment, and human resources. These efforts aim to produce sugarcane with optimal yield quality [11].

PTPN XI is one of the sugar factories in Indonesia, and one of its offices is on Jl. Merak 1, Krembangan, Surabaya city, East Java. PTPN XI has tended to fluctuate in the production process in recent years. This is due to various factors related to the availability of raw materials, including the amount of sugar cane, yield, milling capacity, machinery, and labor [11].

Formulation of The Problem

Based on the explanation of the problem's background, the following is the situation in this study:

1. Whether the land area, amendment and milling capacity affect sugar production in PT Nusantara Plantation XI?
2. Whether the land area affects sugar production in PT Nusantara Plantation XI?
3. Does sugarcane yield affect sugar production in PT Nusantara Plantation XI?
4. Does milling capacity affect sugar production in PT Nusantara Plantation XI?

Writing Purpose

The purpose of this study is directed:

1. To analyze the effect of land area, amendment and milling capacity on sugar production in PT Nusantara Plantation XI.
2. To analyze the effect of land area on sugar production in PT Nusantara Plantation XI.
3. To analyze the effect of sugarcane amendments on sugar production in PT Nusantara Plantation XI.
4. To analyze the effect of milling capacity on sugar production in PT Nusantara Plantation XI.

LITERATURE REVIEW

Characteristics of Cane as a Sugar Producer

Sugarcane is an industrial crop because it is not consumed directly in the form but is marketed as a raw material for the final production, namely sugar [11]. Sugar is a staple food that can be interpreted as a simple carbohydrate produced from sugarcane which is a source of energy. Sugar is used as a sweetener in food or beverages and can also be used as a preservative. The sugar that is commonly traded is crystal sugar. Sugar is one of the most sought-after sweetening ingredients by the public even though there are many types of sweeteners circulating today such as honey, brown sugar, fructose, glucose and tropical sugar. Practicality (granular form), availability and various other advantages make sugar the main choice of the community. Therefore, the demand for sugar continues to increase every year in line with the growth of the population and the growth of industries that use sugar as a raw material [8].

Sugarcane Content

Sugarcane when cut will look fibers and there is a sweet liquid. Fiber and bark are commonly called coir with a percentage of about 12.5% of the weight of sugarcane. The liquid produced is called sap with a percentage of 87.5%. Nira consists of water and dry matter, some of these dry matter are soluble and some are insoluble in sap. The quality of sugar produced by sugarcane is greatly influenced by its main raw material, namely sugarcane juice. The main content in sugarcane juice is water and several other solutes such as sucrose, reduction sugar and other organic and inorganic materials. So to determine the quality of sugarcane, measurements are needed on sugarcane juice [11].

Sugarcane Amendment

Amendment is generally defined as the percent amount that can be utilized from the total amount. The sugarcane yield shows the small amount of sugar content in the cane stalk. Based on the measurement time and the test material, the amendment can be divided into effective amendment, temporary amendment and sample amendment. Effective amendment or amendment is actually the amendment measured after the sugarcane is ground, the material is taken after the grinding process. Meanwhile, the interim amendment is the amendment measured at the time the sugarcane is still being processed. An example amendment is a amendment that is measured before it is cut down. The material is taken while the plant is still in the garden. Example amendments are useful for determining the level of maturity, while temporary amendments are for determining the selling price. The size of the amendment greatly affects the price of sugarcane, so things that affect the amendment need to be considered. Reduced yield can occur during cultivation or in factories [11].

Milling Capacity

The sugar factory operates continuously 24 hours per day for approximately 180 days. Maintaining a smooth grind at an optimal capacity is a must in keeping sugar lost in the factory. This requirement is indeed heavy because of the condition of the equipment. Most sugar factories are concerned. Evidently over the last 5 years the clock stopped grinding in the mill largely due to tool malfunctions. The malfunction of such tools is mostly due to tool damage. The malfunction of the tool is largely due to old equipment and the low quality of maintenance and tool materials which is partly due to possible operating errors. Disruption of the smoothness of the grinding, which inevitably results in the low achievement of milling capacity. Besides causing a reduction in energy use and high sugar loss due to sucrose damage, especially in ingredients with low brix levels such as raw juice, diluted juice, tapis juice and others. The longer the hours stop, the more wasteful and expensive the energy consumption, and the greater the loss of sugar. Therefore, the smoothness of the grinding should be maintained by minimizing

the hours of grinding stops. Minimizing stopping hours is done by maintaining the condition of the equipment, so that it is feasible to operate and supervising its operation as well as possible [1].

Land Area

The reduction of sugarcane land due to the large amount of sugarcane land is used as agricultural land for rice crops by the surrounding community. Farmers prefer to switch to using their land as agricultural land for rice crops because the rice harvest period only uses about 3-4 months, while sugarcane plants spend a longer time about 12 months or more once a year [11].

Land area variables have a positive and significant influence on farmers' sugarcane production at PTPN XI. This shows that if the land area increases, then the amount of sugarcane production of farmers in PTPN XI also increases, and vice versa. The analysis of sugarcane and sugar production in PTPN VII, land area has a significant and positive influence in increasing sugarcane production in PTPN VII [2].

Hypothesis

H1: Amendments, land area and milling capacity affect sugar production in PT Nusantara Plantation XI.

H2: The amendment affects sugar production in PT Nusantara Plantation XI.

H3: Land area affects sugar production in PT Nusantara Plantation XI.

H4: Milling capacity affects sugar production in PT Nusantara Plantation XI.

RESEARCH METHODS

Research Design

This research is conducted through a survey and using quantitative data. The data is in the form of secondary data obtained from the annual report PT. Perkebunan Nusantara XI from 2011 to 2020. The data are available in the Technology and Processing section from reports of sugar production records belonging to PT. Perkebunan Nusantara XI. The data were tabulated based on sugar production, land area, yield, and milling capacity.

Data Source

The data source used in this study is in the form of secondary data obtained from company records (Annual Report) of PT. Nusantara XI plantation from 2011 to 2020.

Types of Data

The type of data used in this study is quantitative data, namely data in the form of numbers and the data used in this study is secondary data.

Research Time and Place

This research has been conducted at PT Nusantara Plantation XI Jl. Merak 1, Krembangan, Surabaya. This research has been conducted from April 01 to May 30, 2022.

Data Collection Techniques

This data can be obtained in the Technology and Processing section to obtain data on sugar production records belonging to PT Nusantara Plantation XI from 2011 to 2020.

Methods and Techniques of Data Analysis

The data is then analyzed using multiple linear regression analysis to determine the linear relationship's direction between the independent variables and the dependent variable. If the relationship is linear, then the regression line equation is obtained as follows :

$$\hat{Y} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e \quad (1)$$

Information:

\hat{Y}	: Sugar production
α	: Constant
β	: Regression coefficient
X_1	: Land area
X_2	: Yield
X_3	: Milling capacity
e	: standard error

The F test analyzed the hypothesis, a test used to simultaneously analyze the effect of the independent variable on the dependent variable. Therefore, this test analyzes the effect of land area, yield and milling capacity as independent variables on sugar production as the dependent variable. Furthermore, the T-test is carried out, which aims to partially analyze the effect of the independent variable on the dependent variable.

RESULTS

The study results show data on sugar production, land area, yield, and milling capacity derived from PTPN XI company records from 2011 to 2020, as shown in Table 1.

Table 1. Sugar Production, Land Area, Yield, and Milling Capacity From 2011 to 2020

<i>Year</i>	<i>Land area (ha)</i>	<i>Yield (tons)</i>	<i>Milling Capacity (TCD)</i>	<i>Sugar production (tons)</i>
2011	70,486	6.88	36,513	302,924
2012	80,171	7.72	36,007	410,475
2013	82,724	6.83	36,681	401,481
2014	89,686	7.39	38,268	418,416
2015	79,881	8.04	41,033	406,517
2016	64,300	6.25	35,976	319,528
2017	59,113	7.23	38,008	306,554
2018	59,143	7.78	33,163	315,798
2019	48,152	7.91	31,536	286,573
2020	48,734	6.98	34,936	263,977

Source: Data Processing Results, 2022.

Based on the data in Table 1, sugar production in PTPN XI fluctuated from 2011 to 2020. The decline in sugar production was influenced by several factors, including land area, yield, and milling capacity. Land area is a factor that affects sugar production because it will produce sugar cane which is the raw material for making sugar. If the land area is small, it will produce a low amount of sugar cane, so the sugarcane that is ready to be milled will decrease. This leads to less sugar production. On the other hand, the larger the land area, the rawer materials will increase, so the sugarcane that is ready to be milled increases and results in more sugar production [11]

Yield is the content of sugarcane in sugarcane stalks, known after the proportion of raw materials and finished products. The low sugarcane yield is also influenced by climate. If the rainfall is high, the yield will tend to be low, so that it can reduce the yield value. In addition, the low yield is also caused by the planting period. If the sugarcane planting period is not optimum, the yield during the cutting process will not be maximized because the age of sugarcane is not optimum. In addition, the decrease in yield is also due to the cleanliness of logging. Many dice (cane leaves) or shoots in the logging process will reduce the yield because of the large amount of dirt involved in the production process [6].

Milling capacity is the capacity in the sugar production process. The milling capacity of the mill every day is not the same, depending on the machine's condition in the factory. If the machine condition is expected, the mill's milling capacity will run normally. However, if the machine's condition in the factory is damaged, it can hamper the production of sugar, and the raw materials will also be affected. If

the raw materials are normal, the milling process will be stable. However, if the raw materials are lacking, the milling process is unstable, causing the milling to stop waiting for the supply of raw materials. This can cause damage to the sap and lead to a decrease in sugar production [4].

DISCUSSION

Results of Analysis of the Relationship between Land Area, Yield, and Milling Capacity on Sugar Production

Based on the results of the analysis of the relationship between land area, yield, and milling capacity with sugar production using multiple linear regression between the factors that affect sugar production in PTPN XI, the following equation is obtained: $\hat{Y} = -59.038 + 3.860 X_1 + 3.860 X_2 - 0.799 X_3 + 0.05$ as shown in Table 2.

Table 2. Multiple Linear Regression Test Results

		<i>Coefficients^a</i>			
		<i>Unstandardized Coefficients</i>		<i>Standardized Coefficients</i>	
<i>Model</i>		<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
					<i>T</i> <i>Sig.</i>
1	<i>(Constant)</i>	-59.038	129.972		-.454 .666
	<i>Land area</i>	3.860	.597	.955	6.466 .001
	<i>yield</i>	22.982	11.253	.223	2.042 .087
	<i>Milling capacity</i>	-.799	3.271	-.036	-.244 .815

a. Dependent Variable: Sugar Production (Y)

Source: Data Processing Results, 2022.

The constant value in the multiple linear regression equation is negative, which indicates the opposite direction between the independent and dependent variables is: -59,038. If the land area, yield, and milling capacity are equal to zero (0), then sugar production will decrease and be influenced by other factors. The regression coefficient of the land area variable (X₁) is 3.860. This value shows a positive influence between the variables of land area and sugar production, meaning that if a land area has a positive effect on sugar production, sugar production will increase by 3,860. The regression coefficient value of the yield variable (X₂) is 22,982, meaning that the yield has a positive and direct effect on sugar production, so that sugar production will increase by 22,982. The regression coefficient value of milling capacity (X₃) is -0.799, meaning that the milling capacity has a negative or opposite effect on sugar production. If the milling capacity variable increases, sugar production will decrease by 0.799.

Results of Simultaneous Analysis of the Effect of Land Area, Yield, and Milling Capacity on Sugar Production

The results of the simultaneous analysis of land area, yield and milling capacity effect on sugar production produced by PTPN XI are listed in Table 3. Based on the results of statistical analysis with the F test, the F-count value is 26,228 with F-table 4.35 where F count > F table with a significance value of 0.001. It can be concluded that land area, yield, and milling capacity simultaneously have a significant effect ($P < 0.05$) on sugar production.

Table 3. Simultaneous Analysis Results with F Test

ANOVA						
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29127.230	3	9709.077	26,228	.001 ^a
	Residual	2221.073	6	370.179		
	Total	31348.303	9			

a. Predictors: (Constant), milling capacity, yield, land area
b. Dependent Variable: sugar production

Source: Data Processing Results, 2022.

Land area is very influential on sugar production because land area is a medium to produce basic raw materials in the sugar production process. The amount of sugarcane produced affects determining the amount of sugar production. The yield also significantly affects sugar production. The high yield indicates a higher sugar content in sugar cane to produce higher sugar products. Likewise, milling capacity greatly affects sugar production. If the milling process is stable, the sugar produced will also be stable, but if the milling process stops, it will cause a decrease in yield and will affect sugar production. The disturbance in the milling process can damage the juice (sap) contained in sugar cane. This follows the results of research conducted by Prasetyani that increased land area can increase the amount of sugar cane, and the yield significantly affects sugar content. If the yield value is high, it will increase the sugar content in sugar cane. Milling capacity and technology also affect sugar production, and if there is damage to the milling machine, it will hamper the sugar production process [11].

Results of Partial Analysis of the Effect of Land Area, Yield, and Milling Capacity on Sugar Production

The results of the partial analysis of land area, yield and milling capacity effect on sugar production produced by PTPN XI are listed in Table 4.

Table 4. Results of Partial Analysis with T-Test

		<i>Coefficients^a</i>				
<i>Model</i>		<i>Unstandardized Coefficients</i>		<i>Standardized Coefficients</i>		
		<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	<i>T</i>	<i>Sig.</i>
1	<i>(Constant)</i>	-59.038	129,972		-.454	.666
	<i>Land area</i>	3.860	.597	.955	6.466	.001
	<i>yield</i>	22,982	11.253	.223	2.042	.087
	<i>Milling capacity</i>	-.799	3.271	-.036	-.244	.815

a. Dependent Variable: Sugar Production (Y)

Source: Data Processing Results, 2022.

Partial Effect of Land Area Variable (X1) on Sugar Production (Y)

Based on the results of data processing, it is obtained that the value of t-count > t-table is 6.466 > 2.446. This indicates that the land area positively and significantly affects sugar production at ($P < 0.05$) PT Perkebunan Nusantara XI.

Land area (X_1) affects sugar production (Y). A large area will produce a lot of sugar cane. Land area is one of the determining factors for the amount of sugar cane because sugar cane is the primary raw material for sugar production. If the land area increases, sugar cane will also increase, and sugar production will increase. The results of this study follow research conducted by Apriawan et al. that land area has a significant and positive effect in increasing sugarcane production in PTPN VII. If there is a decrease in land area, sugarcane production will also decrease [2]. One of the causes of the declining sugarcane harvested area is that during the significant harvesting period, there are sugarcane plants that cannot be harvested, which will be done in the coming period. Similarly, the results of research conducted by Mayangsari show that land area has a positive and significant influence on the sugarcane production of farmers in PTPN XI. If the area of land increases, the amount of sugarcane production by farmers managed by PTPN XI will also increase. On the other hand, if the area of land decreases, sugar cane production will decrease [9].

Effect of Yield (X2) on Sugar Production (Y)

Based on the results of this study, the value of t-count < t-table, which is 2,042 < 2,446. It shows that the yield has no significant effect ($P > 0.05$) on sugar production at PT Perkebunan Nusantara XI.

There is a slight difference from the results of research conducted by Prasetyani, which shows that yield positively affects sugar production in PG Pesantren Baru [11].

Yield is the sugar content in each sugarcane stalk. The resulting yield will affect sugar production. The decrease in yield value was probably due to climatic factors and the growing season, which affected the amount of yield. If the yield decreases, sugar production in PTPN XI will also decrease.

Climatic factors, especially rainfall, determine sugarcane's growth and production, affecting the sap content and yield. Climate change causes rainfall patterns to become erratic and dramatically affects the growing season, where sugarcane growth requires conditions between the rainy and dry seasons. Generally, sugarcane plants require rainfall of 1000-1300 mm/year. It is because, during the vegetative period, sugarcane requires much water, while before it is ripe for harvesting, sugarcane requires a dry state which causes the growth of sugarcane to stop and the process of accumulating sucrose in the sugarcane stalks will begin. If the rainfall is high, the sugarcane maturation process will be delayed, causing the sap content and sugar production to decrease due to low yields [7]. Planting before the dry season can also be done for locations with good irrigation. A suitable planting period helps obtain a high yield [3].

Effect of Milling Capacity (X_3) on Sugar Production (Y)

Based on the analysis results in the study, the sig value was $0.81 > 0.05$, and the t-count $<$ t-table, which is $-0.244 < 2.446$. This shows that milling capacity has no significant effect ($P > 0.05$) on sugar production at PT Perkebunan Nusantara XI. The high reduction in milling capacity may affect statistical analysis results to “not significantly affect sugar production” in PTPN XI. This study does not follow the results obtained by Prasetyani, that milling capacity positively affects sugar production [11].

The milling capacity of the mill every day is not the same, depending on the conditions in the factory. If the factory is operating normally, the milling capacity will also run. Meanwhile, if there is a machinery malfunction, it will inhibit sugar production. Likewise, the availability of raw materials can also cause the milling capacity to be affected. If the raw material supply is regular, the milling process will be stable. However, if the raw materials are lacking, the milling process will be unstable, causing the milling to stop and wait for another supply of raw materials. This causes damage to the juice (sap) and results in decreased sugar production. In addition, the decreased milling capacity is also caused by the engine getting worn and aged so that its performance is less than optimal.

CONCLUSION

From the results of this study, it can be concluded that land area and yield have a positive relationship with sugar production. In contrast, milling capacity has a negative relationship with sugar production. Simultaneously, land area, yield, and milling capacity positively affect sugar production. Partially, land area has a positive and significant effect on sugar production, but yield and milling capacity do not significantly affect sugar production at PT Perkebunan Nusantara XI.

SUGGESION

Based on the research results, it is suggested that PTPN XI increase the land area to increase sugar production and meet domestic sugar demand.

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