Factors affecting sugarcane production in Probolinggo Regency, East Java Province

Masyhuri¹, Lestari Rahayu Waluyati, Fatkhiyah Rohmah, and Imade Yoga Prasada

¹Agricultural Economics, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia

E-mail: dr_masyhuri@yahoo.com; imade.yogap@gmail.com

Abstract. As one of the staple foods, sugar consumption increases every year. The need for sugar is growing very rapidly while an unbalanced increase in production has caused Indonesia to be an importer of raw sugar and refined sugar. This is caused by various factors, one of the main factors is the limited amount of sugarcane production which is the raw material for making sugar. Therefore, in order to increase sugar cane production, this research was conducted with the aim to find out the factors affecting sugarcane production in Probolinggo Regency, East Java. The type of data used is primary data. Data was obtained by interviewing 35 farmers in Probolinggo Regency. The sample location of the study was taken using the purposive sampling method, and farmer samples were taken using the simple random sampling method. Data were analyzed using multiple linear regression methods with OLS (Ordinary Least Square) models. The results showed that the factors affecting sugarcane production in Probolinggo Regency were the variables of farmers' land tenure, the use of organic fertilizers, seeds, and labour.

1. Introduction
Sugar is one of the strategic commodities in Indonesia. Indonesia's sugar consumption tends to increase from time to time [1] [2]. The sugar consumption of the Indonesian population averaged 6.476 kg / capita / year in 2012 and increased in 2015 to 6.805 kg / capita / year [3]. This increase in sugar consumption gives an indication of increasing sugar demand, so it needs to be accompanied by an increase in sugar supply in order to meet domestic sugar needs [4]. However, until now domestic sugar consumption has not been able to be fulfilled properly. This can be seen from the increasing imports of Indonesian sugar from year to year. Based on data from the Ministry of Agriculture of the Republic of Indonesia, Indonesia's sugar import volume in 2013 reached 3,400,000 tons. This figure set the highest volume of sugar imports ever recorded since 1980. The volume of imports was slightly reduced in 2015 to 2,637,020 tons. The high volume of sugar imports in Indonesia can provide an illustration or reflection of the still weak domestic sugar industry. The weak sugar industry is caused by the low efficiency of sugar factories in Indonesia, causing sugar production and productivity to be suboptimal and production costs to be more expensive [5].

The sugar factory in carrying out its production process is very dependent on the availability of raw materials for the sugar industry, namely sugar cane. The sugar factory requires raw materials for the production of sugar in the form of sugar cane for further processing into sugar. However, the sugar cane plants needed for these sugar production activities in the past few years have experienced limited...
The sugar production carried out is unable to meet the production capacity of the sugar mills that are available in each factory. The limitation of sugarcane production is due to the decreasing planting area and harvested area of sugarcane commodities [6]. Because of that, with planting and harvest areas that continue to decline, it is necessary to increase sugarcane production by optimizing the use of available inputs. This research was conducted with the aim to find out the factors that influence sugarcane production in Probolinggo Regency, East Java Province.

2. Materials and Methods

The research location in this study was determined using the purposive sampling method for the reason because Probolinggo Regency is one of the centers of sugar cane production in East Java Province. The respondents of this study were 35 sugar cane farmers and samples were taken using simple random sampling method. The research data were obtained using interview techniques to sugarcane farmer respondents. Data were analyzed using multiple linear regression methods to determine the factors that influence sugarcane production in Probolinggo Regency. Suspected factors that affect sugarcane production in Probolinggo Regency were the amount of phonska fertilizer, amount of liquid fertilizer, amount of organic fertilizer, land area, number of seeds, number of workers, and amount of ZA fertilizer.

The regression model in this study can be written as follows:

\[
\ln Y = \alpha_0 + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 + \alpha_4 \ln X_4 + \alpha_5 \ln X_5 + \alpha_6 \ln X_6 + \alpha_7 \ln X_7 + \mu
\]

Expected sign of estimation \(\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7 > 0\)

Where:

- \(Y\) = Sugarcane production (quintal)
- \(X_1\) = Land area (ha)
- \(X_2\) = Number of seeds (kg)
- \(X_3\) = The amount of phonska fertilizer (kg)
- \(X_4\) = The amount of fertilizer ZA (kg)
- \(X_5\) = Number of workers (working day people)
- \(X_6\) = Amount of liquid fertilizer (ml)
- \(X_7\) = Amount of organic fertilizer (kg)
- \(\mu\) = Error term

Multiple linear regression analysis needs to go through the classical assumption test phase, so that the BLUE (Best Linear Unlimited Estimator) regression results can be obtained. Testing classic assumptions in this study include the normality test, the heteroscedasticity test, and the multicollinearity test. All tests were performed using the help of Eviews 9.0 software. Normality test is a test of research data to find out whether the type of data collected in the field is in accordance with the theoretical distribution (normal distribution). A good regression model is to have residual values that are normally distributed. In this study, the normality test was carried out using the Jarque-Bera test method. Normality test was carried out using the Jarque-Bera method by comparing the probability values of Jarque-Bera with alpha 1%, 5%, and 10%. Residuals are said to be normally distributed if Jarque Bera's probability is greater than the alpha level specified.

Next, the multicollinearity test is one of the classic assumptions tests conducted to test whether the regression analysis model found an influence between the independent variables (independent). A good regression model is a regression model in which there is no correlation between independent variables. The existence of multicollinearity can be seen the value of correlation between independent variables. A regression model in which multicollinearity is not detected is a model that has a correlation value below 0.8. Multicollinearity test was performed using the correlation test method between each independent variable used in the model. The assumption of multicollinearity is fulfilled when the correlation coefficient between each independent variable is less than 0.80.

In addition, heteroscedasticity test is a classic assumption test conducted with the aim to find out whether in the regression model variance and residual inequality occur one observation to another. A good regression model is homoscedasticity, that is, the variance and residuals of one observation to
another are fixed. The heteroscedasticity test was carried out by the White test method with the Obs*R² value indicator not exceeding the critical chi-square value (X²) at a predetermined level of significance, the conclusion was that the regression model was homoscedasticity [7].

3. Results and Discussion

3.1. Normality Test
In this study, the normality test was carried out using the Jarque-Bera test method. The results of normality testing in the regression model used can be seen in Figure 1 as follows.

![Figure 1. Jarque-Bera Test Results](image)

The Jarque-Bera probability value is 0.28. The probability value was greater than the alpha level of 1%, 5%, or 10%, so H0 which states that the normally distributed residuals failed to be rejected. The rejection of H0 shows the residual regression model used to determine the factors that affect sugarcane production in Probolinggo Regency, East Java, which was normally distributed.

3.2. Multicollinearity Test
The existence of multicollinearity can be seen the value of correlation between independent variables. A regression model in which multicollinearity is not detected is a model that has a correlation value below 0.8. The results of multicollinearity test on the regression model used can be seen in table 1 as follows.

| Series: Residuals | Sample 1 35 | Observations 35 |
|-------------------|-------------|-----------------|
| Mean              | -2.57e-16   |                 |
| Median            | -0.118040   |                 |
| Maximum           | 1.164671    |                 |
| Minimum           | -0.814867   |                 |
| Std. Dev.         | 0.595411    |                 |
| Skewness          | 0.305637    |                 |
| Kurtosis          | 1.827481    |                 |
| Jarque-Bera       | 2.549833    |                 |
| Probability       | 0.279454    |                 |

![Figure 1. Jarque-Bera Test Results](image)

Based on table 1 it can be seen that all independent variables in the regression model used in this study have a correlation coefficient value smaller than 0.80. These results illustrate that the model used to determine the factors that affect sugarcane production in Probolinggo Regency was free from
multicollinearity problems. Therefore, the model can be used well to determine the factors that affect sugarcane production.

3.3. Heteroscedasticity Test
In this study, a white or general’s heteroscedasticity test is used. Heteroscedasticity test results in the regression model of this study can be seen in table 2 as follows.

| Table 2. Heteroscedasticity Test Results |
|-----------------------------|-------------------|------------------|
| F-statistic                 | 0.912061          | Prob. F(7,27)    | 0.5122 |
| Obs*R-squared              | 6.693388          | Prob. Chi-Square(7) | 0.4615 |
| Scaled explained SS        | 1.648032          | Prob. Chi-Square(7) | 0.9767 |

Based on table 2 it can be seen that the probability value Obs*R-squared is equal to 0.4615. The probability value Obs*R-squared was greater than α = 1% so H0, which represents the variance of the error term constant value, fails to reject. These results indicate the regression model used did not have a heteroscedasticity problem or the model has homoscedasticity properties.

3.4. Factors Affecting Sugar Cane Production
The analysis in this study was used to determine the factors that affect sugarcane production in Probolinggo Regency. The independent variable in this study were the variable number of phonska fertilizer, amount of liquid fertilizer, amount of organic fertilizer, land area, number of seeds, number of labour, and the amount of ZA fertilizer, while the dependent variable was the variable amount of sugarcane production. The results of multiple linear regression factors that affect sugarcane production in Probolinggo, East Java can be seen in table 3 below.

| Table 3. Factors Affecting Sugar Cane Production in Probolinggo Regency |
|-----------------------------|-------------------|------------------|
| Independent Variables       | Exp. Sign         | Coefficient      | Prob. t statistic |
| Phonska fertilizer          | +                 | 0.0131 ns        | 0.9109 |
| Liquid fertilizer           | +                 | -0.1709 ns       | 0.2263 |
| Organic fertilizer          | +                 | 0.0720*          | 0.0735 |
| Land area                   | +                 | 0.2707*          | 0.0609 |
| Seeds                       | +                 | 0.0501*          | 0.0671 |
| Labour                      | +                 | 0.3926**         | 0.0109 |
| ZA fertilizer               | +                 | -0.1740 ns       | 0.4601 |
| Constanta                   | +/-               | 3.8871**         | 0.0119 |
| Adjusted R²                 |                   | 0.7198           |       |
| Prob,(Fstatistic)           |                   | 0.0000***        |       |

Note: ** significant at 1% error rate (α = 0.01)
* significant at 5% error rate (α = 0.05)
ns significant at an error rate of 10% (α = 0.1)
ns not significant

The statistical F probability value is 0.00. This value is smaller than alpha 1%, so it means that all independent variables tested (the amount of phonska fertilizer, amount of liquid fertilizer, amount of organic fertilizer, land area, number of seeds, number of labor, and amount of ZA fertilizer) together significant effect on sugarcane production in Probolinggo Regency, East Java. In addition, the adjusted R² value of the regression model was 0.7198. This value shows that 71.98% of the variation of the dependent variable, namely sugarcane production can be explained by the variable amount of phonska fertilizer, amount of liquid fertilizer, amount of organic fertilizer, land area, number of seeds, number
of workers, and amount of ZA fertilizer, while the remaining 28.02% was explained by other variables outside the regression model used. Table 3 also shows the value of the regression constant is 3.8871 and is significant at the alpha level of 5%. The value of the regression coefficient shows the influence of other variables outside the model was 3.8871% on sugarcane production.

Variables that influence sugarcane production in Probolinggo Regency were the amount of organic fertilizer, land area, number of seeds, and number of labor. The variable amount of organic fertilizer was significant at the alpha level of 10% with a regression coefficient of 0.0720. The coefficient value means that each increase in the use of organic fertilizer by 1%, then sugarcane production can increase by 0.0720%. Organic fertilizer can help sugarcane to produce higher production [8] [9]. In addition, the sugarcane area variable was also significant at alpha 5% with a coefficient of 0.2707. The regression coefficient of land area of 0.2707 means that each increase in land area of 1% will increase sugarcane production by 0.2707%. The wider cultivated land area can help to support the increase of aquaculture commodity production [10]. The variable number of sugarcane seedlings used was significant at the alpha level of 10% with a regression coefficient value of 0.0501. The coefficient value means that each increase in the use of the number of sugarcane seedlings by 1%, then sugarcane production can increase by 0.0501%. The use of new seeds in Probolinggo Regency was included in the low category, so it needs to be increased to increase sugarcane production. The variable number of workers is also significant at the alpha level of 5% with a regression coefficient of 0.3926. The regression coefficient of the variable number of workers shows that each increase in labor use by 1%, then sugarcane production can increase by 0.3926%. Increasing the use of labor can increase efficiency in the production process, so that the higher use of labor can increase sugarcane production [11] [12].

4. Conclusion
Factors that influence sugarcane production in Probolinggo Regency, East Java Province were the amount of organic fertilizer, land area, number of seeds, and the number of workers. All of these variables had a positive influence on sugarcane production. This positive effect means that an increase in each of these variables will cause an increase in sugarcane production.

References
[1] Almamalik L 2017 Analysis of the competitiveness of state-owned sugar mills J E Bis 1 76–90
[2] Marta S. and Erza O 2017 Analysis of the efficiency of the sugar industry in Indonesia using the Data Envelopment Analysis (DEA) method 2001-2010 E Media 2 1–19
[3] Kementan 2016 Sugarcane Outlook Agricultural Commodities Plantation Sub-sector Jakarta: Pusat Data dan Informasi Pertanian Kementerian Pertanian
[4] Pujitasisih, H. Arifin, B. and Situmorang S 2014 Analysis of the position and level of dependence on imports of white crystal sugar and Indonesian refined crystal sugar in the international market JIA 1 1–6
[5] Tayibnapis, A. Z., Sundari, M. S., and Wuryaningsih, L. E. 2016 Increasing the competitiveness of sugar mills in Indonesia in the era of the ASEAN economic community J Econ Man Research 2 225–236
[6] BPS 2017 Indonesian Sugarcane Statistics 2017 Jakarta: Badan Pusat Statistik Indonesia
[7] Gujarati, D. N. 2004 Basic Econometrics 4th ed. New York: The McGraw-Hill Companies
[8] Awami, S. N., Sa’diyah, K., and Subekti, E. 2018 Factors affecting the production of shallots (Allium ascalonium L) in Demak Regency J Agrifo 2 1–10
[9] Sapar, Rismawati and Adrian 2015 Factors affecting cocoa production in Bua District, Luwu Regency, J Dev Econ 1 32–40
[10] Prabowo, A. S. 2015 Analysis of factors affecting sugar production in Central Jaw in 2004-2013 E Dev Analysis Journal 1 10-15
[11] Manggala, R. B., and Boedi, A. 2018 Factors affecting rice production in Sumengko Village, Sukomoro District, Nganjuk Regency J Econ 3 441-452
[12] Rohimah, U., Astuti, A., and Sudrajat, I. S. 2017 Factors affecting the production of lowland rice
on new open paddy fields (Oryza sativa L.) (Case study of Sindangasih Village, Cikatomas District, Tasikmalaya Regency, West Java). Sci J Agrity 2 1–11