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CORN PRODUCTION EXPLORATION OF CENTRAL SULAWESI USING MULTIPLICATIVE WINTER MODEL

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ABSTRACT

Corn is a very important food ingredient after rice. Central Sulawesi corn production data is in the form of time series data which every year in certain months increases or decreases in production. Therefore, the method that can be used for forecasting is the winter multiplicative method. This study aims to build the best model for forecasting corn production in Central Sulawesi using the winter multiplicative method. The results of this study are used to explore corn production for the next period. Modeling is done by selecting the best combination of parameters and the best combination of model parameters is obtained with a mean absolute percentage error (MAPE) of 18% with a value of $\alpha = 0,5$; $\gamma = 0,1$; and $\beta = 0,1$. The data plot of the forecasted corn production shows fluctuations which indicate seasonal factors and trends in it.

Keywords: *corn, exploration, forecasting, multiplicative, winter*

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INTRODUCTION

Corn is one of the strategic commodities needed in the form of food for humans and feed for livestock consumption. During the last 5 years, it is estimated that national corn production grows by an average of 12.32% per year. Corn growth was also followed by an increase in harvested area from 2014 to 2018 of around 11.13%, and productivity growth of 1.57% per year (Kementerian Pertanian, 2018).

The corn production of farmers in Central Sulawesi Province in the last four years has experienced a significant increase. In 2014 the corn production of Central Sulawesi farmers was only around 170,000 tons, increased in 2016 and 2017 to 200,000 tons. There are three districts that have a corn development area in Central Sulawesi, namely Tojo Una-una with an area of 8,228 hectares, Poso with 2,335 hectares, and Buol with 1,188 hectares. However, the development of corn commodity in Central Sulawesi covers almost all districts (BPS, 2018). Data related to corn production is available every month and is in the form of time series.

In the forecasting process, there are several methods that are often used to predict time series data. Meanwhile, in the time series analysis, there are several data patterns such as horizontal data patterns, seasonal data patterns, trend data patterns, and cyclic data patterns. The case of corn production is seasonal data, therefore the methods that can be used for forecasting are additive and multiplicative winter methods. This method can handle modeling on data that shows trend and seasonal patterns (Makridakis, et al., 1999).

Previous research has been conducted by Fani (2017) discussing the comparative analysis of the winter exponential smoothing method and the event based method to determine the best product sales forecasting of a company. The research results that the winter exponential smoothing method is more appropriate in forecasting because it produces the smallest error value.

This research was conducted to build a multiplicative winter model for exploration and forecasting which is expected to provide information to the Central Sulawesi provincial government regarding the development of corn production in the future.

MATERIALS AND METHODS

1. Data

This study uses secondary data from the Department of Agriculture of Central Sulawesi Province which consists of monthly data for the last 10 years. The research variable used is corn production data (tons) in the form of monthly data.

2. Data Analysis

a. Collect data, perform descriptive analysis, and plot data
b. Perform modeling using all combinations of alpha, gamma, and betta parameter values for the multiplicative winter model as follows (Hanke & Winchern, 2005):
   $S_t = (L_t + T_t)M_{t-p}$ (1)
   where are the model components:
   $L_t = \alpha(Y_t / M_{t-p}) + (1 - \alpha)(L_{t-1} + T_{t-1})$ (2)
   $T_t = \gamma(L_t - L_{t-1}) + (1 - \gamma)T_{t-1}$ (3)
   $M_t = \delta(Y_t / L_t) + (1 - \delta)M_{t-p}$ (4)
   Where S_t is the smoothing value, L_t t is the value at the level stage, T_t is the value at the trend stage, and M_t is the value at the seasonal stage
c. Calculating the MAPE (mean absolute percentage error) value to obtain the best model, where if the resulting value is getting smaller, then the forecasting results will be closer to the right using the following equation (Santoso, 2005):
   $$MAPE = \frac{100\%}{n}\sum_{t=1}^{n}\left|\frac{Z_t - \hat{Z}_t}{Z_t}\right| \quad (5)$$
d. Exploring the forecast results of corn production using the best model, where the forecast results are obtained using the following equation (Hameed, 2015):
   $F_{t,h} = L_t + h(T_t) + M_{t-q+h}$ (6)
   Where $F_{t,h}$ is the forecast value.
e. Draw a conclusion.

RESULTS AND DISCUSSION

1. Descriptive Analysis

Descriptive analysis is used to provide an overview of the corn production data of Central Sulawesi province, the description of the data in question can be seen through the average value, standard deviation, and maximum and minimum values based on Central Sulawesi corn production data for the last 10 years.

Table 1. Descriptive Statistics of Corn Production in Central Sulawesi in the Last 10 Years

Month	Mean	Standard Deviation	Maximum	Minimum
January	13.718,1	5445,7	25.057,50	5.289,90
February	17.229,4	6077,7	31.792,50	11.676,80
March	19.659,4	10332	41.350,20	10.105,10
April	20.294,1	9539,1	42.418,80	11.566,10
May	16.362,5	5277,7	26.609,10	10.258,60
June	15.527,8	4331,1	23.739,20	11.499,60
July	14.470,7	3900,7	23.455,70	10.128,40
August	17.159,6	5943,4	27.842,20	11.248,60
September	16.980,1	7530,8	33.106,50	10.279,10
October	16.838,1	7608,7	34.747,60	10.727,80
November	17.908,6	8442,1	36.610,40	10.418,60
December	18.971,6	12776,2	50.630,70	10.686,10

Based on the table above, it is found that the highest average corn production was in April with a total of 20,294.1 tons with a maximum production value of 42,418.8 tons and a minimum production of 11,566.1 tons, while the lowest average was in the month of January with a total of 13,718.1 tons, with a maximum value of production of 25,057.5 tons, and a minimum value of production of 5,289.9 tons. Next, a plot is carried out to see the pattern of data on corn production in Central Sulawesi for the last 10 years.

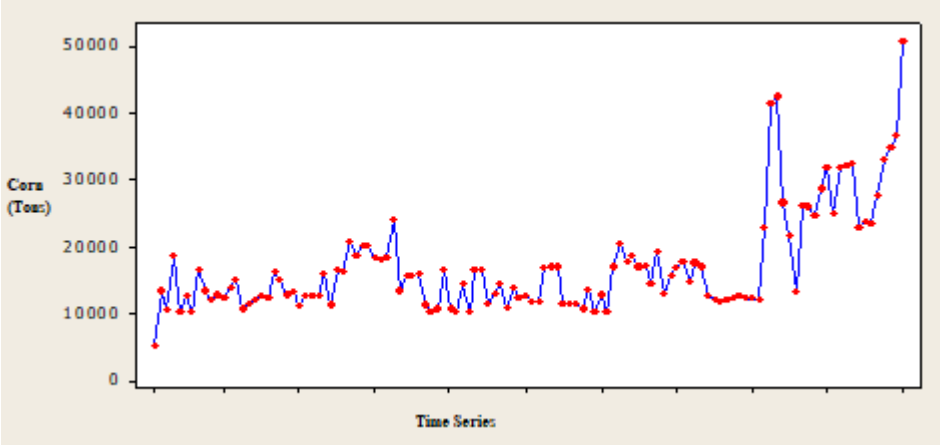

Figure 1. Plot of Central Sulawesi Corn Production Data in the Last 10 Years

The plot above shows that maize productivity data for Central Sulawesi in the last 10 years is influenced by a trend pattern where maize productivity shows fluctuations that continue to increase. Seasonal factors were also identified in this corn production data which showed that there was a pattern of changes that repeated automatically from year to year. It also shows that the data is not stationary or does not range between seasonal mean values. This is sufficient to indicate that Central Sulawesi maize production data is data that has a trend and seasonal pattern with fluctuating seasonal variations.

2. Multiplicative Winter Modeling

The selection of multiplicative winter model parameters is done by selecting the best model for the combination of parameter values of α, β, dan γ where the parameter values range from 0 to 1 (0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8; 0.9) where in this study the selection of the best model was carried out by a combination of values of α, β, and γ so there will be 729 combinations of models to compare and get the best multiplicative model. The following results are obtained:

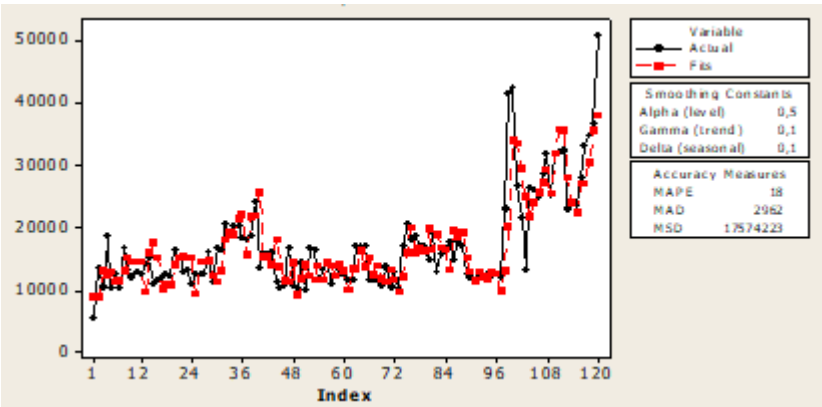

Figure 2. Plot of Multiplicative Winter Modeling Results

Based on the plot of the multiplicative winter modeling results above, the best model is obtained with the parameter value of α = 0,5; γ = 0,1; dan β = 0,1 which produces the smallest MAPE value of 18%. Because the MAPE value obtained is less than 20%, it can be said that the multiplicative winter model is good for use in forecasting corn production in Central Sulawesi. The plot of corn production data above shows fluctuations which indicate seasonal factors and trends in it. The graph also shows that the forecast value of maize productivity (red line) is close to the actual value (black line) or not much different from the actual value of Central Sulawesi maize productivity, so it can be concluded that the multiplicative winter model is quite well used to predict maize productivity in Central Sulawesi Province.

CONCLUSION

Based on the overall results of the analysis that has been carried out, it can be concluded that the forecasting in the last 10 years of corn production in Central Sulawesi is good by using the winter multiplicative method. This is due to seasonal variations that are not constant and there is a trend effect in the data. Then after forecasting, the mean absolute percentage error value is 18%.

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