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PREDICT THE PRICE OF CURLY RED CHILI IN NORTH SUMATRA USING THE HOLT WINTERS ADDITIVE METHOD

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ABSTRACT

Curly red chilies are one of the vegetable commodities that have an effect on national economic growth. North Sumatra is one of the largest red chilli have a problem with price fluctuations which will result in inflanation. Erratic chili prices will have an impact on society and the country. The right policy to avoid negative impact on price fluctuations of North Sumatra's curly red chilies is to predict it in the future. The purpose of this study was to obtain the result of the prediction of the price of North Sumatra curly red chilies. The results of this analysis can be used in determining the right policy. The method used in this study is the Holt Winters Additive Method, because the Holt Winters Additive Method is a method that can be used for forecasting data that has elements of trend and seasonality. The data used in this study is the average price of North Sumatra curly red chilies per week from January 2020 to February 2021 which is obtained from the National Strategic Food Price Information Center. After testing the price of curly red chilies in North Sumatra, a forecast data plot is obtained which tends to follow the actual data. Then the error rate is measured using MAPE (Mean Absolute Percentage Error). The MAPE results obtained were 10.15% with the best parameters $\alpha = 0.84$, $\beta = 0.09$ and $\gamma = 0.83$. this means that the Holt Winters Additive method has a good level of accuracy used to predict the price of curly red chilies in North Sumatra Province.

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1. INTRODUCTION

Red chili is one of the vegetable commodities that affect national economic growth. North Sumatra is one of the largest red chili producing centers and occupies the third position in Indonesia. Chili is listed as a commodity with very high price fluctuations. Even tend to experience a sharp increase or decrease. The fluctuations in food prices will affect the welfare of producers, consumers and the state.

Based on data information from the National Strategic Food Price Information Center in 2020 to 2021 the price of curly red chili fluctuates every week and even every day. The Central Statistics Agency (2020) stated that in October 2020 there was an inflation of 0.07%. By type of household expenditure, general inflation occurred due to an increase in prices as indicated by an increase in the index for the food, beverage and tobacco category by 0.29%. From this inflation, red chilies contributed dominantly with inflation of 0.09%. The cause of the increase in chili prices is caused by several factors including weather factors, disease outbreaks on plants, price games from middlemen, weak national food processing and weak price regulation

regulations by the government (Santoso, 2016). In addition, the factors that cause high curly red chili prices are high production costs at the farm level. The production costs include seeds, fertilizer, water and the distance from the chili garden to the collectors. To avoid the negative impacts of chili price fluctuations that can affect inflation, it is important to forecast the price of curly red chili, especially in North Sumatra Province. So that it can be used as a decision supporter related to the price of curly red chili and the results of the analysis can be used in determining the right policy. The method used in this study is the Holt Winters Additive Method, because the Holt Winters Additive method is a method that can be used for forecasting data that has trend and seasonal elements.

2. RESEARCH METHODE

This study began by collecting secondary data on the price of curly red chili in North Sumatra per week starting from January 2020 to February 2021 which was obtained from the website of the National Strategic Food Price Information Center. Then the data is calculated using the Holt Winters Additive Method

2.1 The Holt Winters Method

The Holt-Winters method is a method used to overcome the problem of trends and seasonal indications. This method is a combination of the Holt method and the Winters method. The emphasis of this method is on the value of level (α), slope (β), and seasonal effects (γ). Parameter value level(α), slope slope (β), and seasonal effect (γ) are between 0 and 1. Values close to 0 mean that the weighting effect is relatively small on the most recent observed values when forecasting future values.

Forecasting with this method in general does not always have to meet time series rules such as the significance of autocorrelation and stationarity (Jatmiko, 2017). There are two types of Holt Winter Exponential method, namely Additive Model and Multiplicative Model. The Additive model with the seasonal addition method is suitable for predicting time series with the amplitude (height) of the seasonal pattern which does not depend on the average level or data size so that it is constant. There are three equations used in the Additive method, namely:

Level

$$l_t = \alpha(Y_t - S_{t-s}) + (1-\alpha)(l_{t-1} + b_{t-1}) \quad (2.1)$$

Trend

$$b_t = \beta(l_t - l_{t-1}) + (1-\beta)b_{t-1} \quad (2.2)$$

Seasonal

$$S_t = \gamma(Y_t - l_t) + (1-\gamma)S_{t-s} \quad (2.3)$$

Forecast

$$F_{t+m} = l_t + mb_t + S_{t-s+m} \quad (2.4)$$

To initialize this forecasting method, an initial value for smoothing level is required (l_s), trend (b_t), and seasonal index(S_t). In order to get an estimate of the initial value of the seasonal index, complete data is needed for at least one season, then the trend and smoothing values will be initialized in period s. The initial value of the level smoothing constant or parameter is obtained using the first season average:

$$l_s = \frac{1}{s}(Y_1 + Y_2 + \cdots Y_s) \quad (2.5)$$

To initialize the trand it is better to use complete data for two periods:

$$b_s = \frac{1}{s}\left(\frac{Y_{s+1}-Y_1}{s} + \frac{Y_{s+2}-Y_2}{s} + \cdots \frac{Y_{s+s}-Y_s}{s}\right) \quad (2.6)$$

Next to initialize the seasonal index of the additive method, namely:

$$S_1 = Y_1 - l_s, S_2 = Y_2 - l_s, \ldots, S_s = Y_s - l_s \quad (2.7)$$

Where:

Y_t = Actual value in period t

l_t = Forecast smoothing value for period t

b_t = Trend smoothing value

S_t = Seasonal component of the period

m = Number of periods to be forecast

α = Smoothing parameters for level$(0 < \alpha < 1)$

β = Smoothing parameter for trend$0 < \beta < 1)$

γ = Smoothing parameters for seasonal$(0 < \gamma < 1)$

s = Season length

F_{t+m} = Forecast for m periods ahead of t

3. RESULT AND ANALYSIS

3.1 Calculation with Holt Winters Additive method

The data to be analyzed in this study is time series data on the price of curly red chili in North Sumatra Province from January 2020 to February 2021 obtained from the National Strategic Food Price Information Center. The data is in the form of 67 data.

The first step to finding the forecast is to set a value for the parameter α, β, dan γ by taking any value with conditions between 0 and 1. Then determine the initial value, with the following formula:

1) Calculate the initial value of level smoothing (L_0)

$$L_s = \frac{1}{s}(Y_1 + Y_2 + \cdots + Y_s) \quad (2.5)$$

$$L_0 = \frac{1}{5}(35000 + 34100 + 31300 + 31200 + 33600)$$

$$L_0 = 33040$$

2) Calculate the initial value of trend smoothing (b_0)

$$b_s = \frac{1}{s}\left(\frac{Y_{s+1}-Y_1}{s} + \frac{Y_{s+2}-Y_2}{s} + \cdots \frac{Y_{s+s}-Y_s}{s}\right) \quad (2.6)$$

$$b_0 = \frac{1}{5}\left(\frac{37450-35000}{5} + \frac{34500-34100}{5} + \frac{39750-31300}{5} + \frac{44250-31200}{5} + \frac{39850-33600}{5}\right)$$

$$b_0 = 1224$$

3) Calculating the initial value of seasonal smoothing ($S_1, S_2 \ldots S_s$)

$$S_1 = Y_1 - l_s, S_2 = Y_2 - l_s, \ldots, S_s = Y_s - l_s \quad (2.7)$$

$$S_1 = 35000 - 33040 = 1960$$

$$S_2 = 34100 - 33040 = 1060$$

$$S_3 = 31300 - 33040 = -1740$$

$$S_4 = 31200 - 33040 = -1840$$

$$S_5 = 33600 - 33040 = 560$$

4) Calculating the forecast value for the 6th period, namely on the 1st Sunday in February 2020, then we get

$$F_6 = l_0 + b_0 + S_1$$

$$F_6 = 33040 + 1224 + 1960$$

$$F_6 = 36224$$

After obtaining the initial value, the next step is to find the smoothing value for the overall data, trends and seasonality. Here the author uses the value of alpha = 0,84, beta = 0,09 and gamma = 0,83. Based on the Holt Winters Additive formula, it is obtained:

1) Calculating level smoothing value:

$$l_7 = \alpha(Y_7 - S_2) + (1 - \alpha)(l_6 + b_6)$$

$$l_7 = 0{,}84(34500 - 1060) + (1 - 0{,}84)(35293{,}84 + 1316{,}69)$$

$$l_7 = 33947{,}28$$

2) Calculating trend smoothing value:

$$b_7 = \beta(l_7 - l_6) + (1 - \beta)b_6$$

$$b_7 = 0{,}09(\ 33947{,}28 - 35293{,}84) + (1 - 0{,}09)(1316{,}69)$$

$$b_7 = 1076{,}99$$

3) Calculating the value of seasonal smoothing:

$$S_7 = \gamma(Y_7 - l_7) + (1 - \gamma)S_2$$

$$S_7 = 0{,}83(34500 - 3347{,}28) + (1 - 0{,}83)(1060)$$

$$S_7 = 638{,}95$$

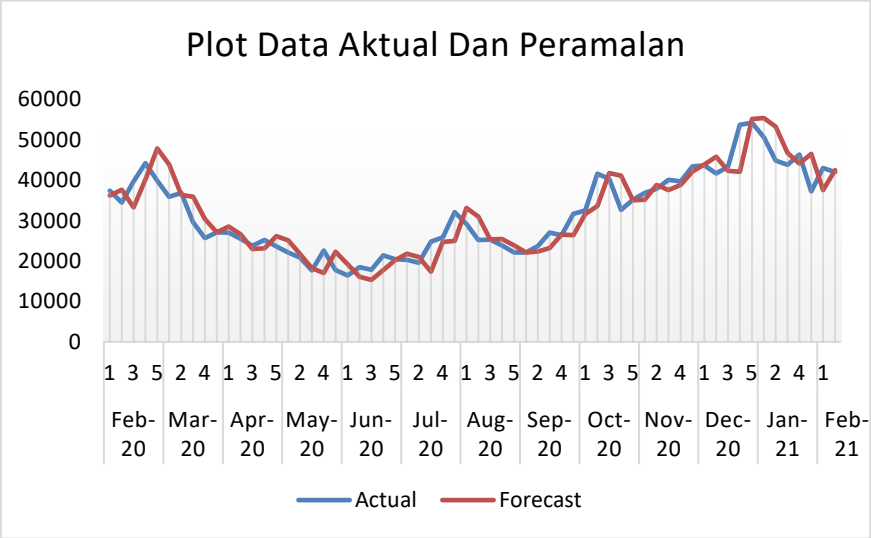
4) Calculating the value for forecasting the 8th period, namely on the 3rd Sunday of February 2020:

$$F_8 = l_7 + b_7 + S_3$$

$$F_8 = 33947{,}28 + 1076{,}99 + (-1740)$$

$$F_8 = 33284{,}28$$

This process is repeated until the 72nd period. Until the forecast is obtained for February and March 2021. After forecasting obtained by the Holt Winters Additive Method. Then the forecasting results are plotted and compared to the actual data, the plot is obtained as follows.



Source: Microsoft Excel

Figure 4.2 Plot of Actual Data and Forecasting Using Holt Winters Additive

Based on the plot above, it can be seen that the forecasting of curly red chili prices in North Sumatra Province using the Holt Winters Additive method produces forecast values that tend to follow the actual data pattern. The X-axis displays data for the week followed by the month and year, the Y-axis shows the price range. The blue line shows the actual data and the orange line shows the forecast results.

The forecasting results obtained from the formula below are as follows:

$$F_{t+m} = l_t + mb_t + S_{t-s+m} \quad (2.4)$$

Calculating the forecast for the 68th period i.e. the third week in February 2021:

$$F_{68} = l_{67} + mb_{67} + S_{63}$$

$$F_{68} = 42895{,}62 + (1)(145{,}149) + (24{,}82164)$$

$$F_{68} = 43065{,}59$$

Calculating the forecast for the 69th period i.e. the fourth week in February 2021:

$$F_{69} = l_{67} + mb_{67} + S_{64}$$

$$F_{69} = 42895{,}62 + (2)(145{,}149) + (290{,}7778)$$

$$F_{69} = 43476{,}70$$

Calculating the forecast for the 70th period i.e. the fifth week in February 2021:

$$F_{70} = l_{67} + mb_{67} + S_{65}$$

$$F_{70} = 42895{,}62 + (3)(145{,}149) + (-1172{,}75)$$

$$F_{70} = 42158{,}32$$

Calculating the forecast for the 71st period i.e. the first week of March 2021:

$$F_{71} = l_{67} + mb_{67} + S_{66}$$

$$F_{71} = 42895{,}62 + (4)(145{,}149) + (-204{,}983)$$

$F_{71} = 43271{,}23$

Calculating the forecast for the 72nd period i.e. the second week in March 2021:

$F_{72} = l_{67} + mb_{67} + S_{67}$

$F_{72} = 42895{,}62 + (5)(145{,}149) + (-832{,}988)$

$F_{72} = 42788{,}38$

4. CONCLUSIOON

Calculations using the Holt Winters Additive method produce the best parameter values selected by trial and error with the help of Solver, namely α = 0,84 β = 0,09 and γ = 0,83 by obtaining a MAPE value of 10.15% which means that the Holt Winter Additive method has a good accuracy value used to predict the price of curly red chili in North Sumatra Province. With the following equation form:

$l_t = 0{,}84(Y_t - S_{t-s}) + (0{,}16)(l_{t-1} + b_{t-1})$
$b_t = 0{,}09(l_t - l_{t-1}) + (0{,}91)b_{t-1}$
$S_t = 0{,}83(Y_t - l_t) + (0{,}17)S_{t-s}$

The results of the prediction of the price of curly red chili in North Sumatra for the next period using the Holt Winters Additive method are as follows:

- 3rd week of February 2021 : Rp43.065,59,-/Kg
- 4th week of February 2021 : Rp43.476,7,-/Kg
- 5th week of February 2021 : Rp42.158,32,-/Kg
- 1st week of March 2021 : Rp43.271,23,-/Kg
- 2nd week of March 2021 : Rp42.788,38,-/Kg

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