Forecasting the Production Results of Medicine Horticultural Plants (Biofarmacies) in North Sumatra in 2020 and 2021 Using Double Exponential Smoothing Brown Method

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Abstract. Indonesian medicinal plants have a high contribution to world drug production. North Sumatra is one of provinces that produces a variety of traditional medicinal plants. The data in this study is secondary data obtained from the Central Statistics Agency of North Sumatra which is data on the amount of production of medicinal horticultural plants (biopharmaceuticals) from 2007-2019 using the method Double Exponential Smoothing Brown. The purpose of this research is to get the parameters α and shape forecasting equation that can be used to estimate the amount of production of the total production of horticultural crops medicin from 2006 to 2018 by using the size of the precision of the forecasting Mean absolute Percentage Error in the method of Double Exponential Smoothing Brown. The parameter α is best used to predict the amount of horticultural crop production of medicinal was 0.24 with a yield forecasting in 2020 amounted to 8,454,007.24 kg and in 2021 amounted to 7,779,411.27 kg.

Keyword: Double Exponential Smoothing Brown, Forecasting, Production Of Medicinal Horticultural Plants, Biopharmaceuticals

yang digunakan untuk meramalkan jumlah produksi tanaman hortikultura obat (biofarmaka)
adalah 0,24 dengan menghasilkan peramalan pada tahun 2020 sebesar 8.454.007,24 kg dan
tahun 2021 sebesar 7.779.411,27 kg.

**Kata Kunci:** Metode Branch and Bound, Optimisasi Produksi, Program Linier, Program
Bilangan Cacah.

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### 1. Introduction

Forecasting is thinking of a quantity, for example the demand for one or more products in the
future period. In essence, forecasting is only an estimate (guess), but by using certain techniques,
forecasting becomes more than just an estimate [1]. To get accurate forecasting results,
appropriate forecasting methods are used. So to predict the yield of medicinal horticultural crops
(bio-pharmaceuticals) in North Sumatra, the author uses method Double Exponential Smoothing
Brown's. According to Double Exponential Smoothing Brown's is a linear model proposed by
Brown [2]. This method is used when the data shows a trend. Trend is a smoothed estimate of
the average growth at the end of each period.

For his research using the Method Double Exponential Smoothing Brown. The Double
Exponential Smoothing method was chosen as the best forecast method for forecasting the
consumer price index (CPI) in the city of Samarinda [3]. The results of forecasting the number of
CPI in the city of Samarinda show that there is an increase from month to month throughout the
year. Researched unemployment forecasting using the method double exponential smoothing in
East Kalimantan Province [4]. For his research using the Double Exponential Smoothing Brown
Method, the DES method is proposed to be superior in the accuracy and robustness of the data
predicted from the Mean Absolute Percentage Error (MAPE) [5].

### 2. Related Work

#### 2.1 Forecasting Basic Concepts

Forecasting is the thought of a quantity, for example the demand for one or more products in the
future period. In essence, forecasting is only an estimate (guess), but by using certain techniques, forecasting becomes more than just an estimate [1].

#### 2.2 Function and Purpose of Forecasting

The function of forecasting or forecasting is seen at the time of decision making. A good
decision is a decision that is based on consideration of what will happen when the decision
is implemented. If the predictions that we make are not accurate, the forecasting problem is
also a problem that we always face [1].
2.3 Method Smoothing (smoothing)

Method smoothing is the method used to set the past data in accordance with the data that occur seasonally, by averaging a series of data up to a distance and amount of data tends to/almost balanced [6].

2.4 One-Parameter Linear Double Exponential Smoothing Method from Brown

To get accurate forecasting results, the right forecasting method is used. So to predict the yield of medicinal horticultural crops (biopharmaceuticals) in North Sumatera, the author uses method Double Exponential Smoothing Brown's. According to Double Exponential Smoothing Brown's is a linear model proposed by Brown [2]. This method is used when the data shows a trend. Trend is a smoothed estimate of the average growth at the end of each period. With the analogy used when departing from a single moving average to a it can also be departed from a double moving average to a double exponential smoothing. Such a move may be interesting because one of the limitations of the Single Moving Average (i.e. the need to store the last n values) is still the Double Moving Average. Double Exponential Smoothing can be calculated only by three data values and the value for $\alpha$. This approach also gives decreasing weight to past observations. For this reason Double Exponential Smoothing is preferred over Double Moving Average as a forecasting method in most of the cases.

Steps in using Double Exponential Smoothing Brown is as follows:

1. Determine the value smoothing first $S_t'$

$$S_t' = \alpha X_t + (1 - \alpha)S_{t-1}'$$  \hspace{1cm} (1)

2. Determining the value of smoothing the second $S_t''$

$$S_t'' = \alpha S_t' + (1 - \alpha)S_{t-1}''$$  \hspace{1cm} (2)

3. Determining the value of a constant period $a_t$

$$a_t = 2S_t' - S_t''$$  \hspace{1cm} (3)

4. Determining the value of smoothing constant (bt)

$$b_t = \frac{\alpha}{(1-\alpha)}(S_t' - S_t'')$$  \hspace{1cm} (4)

5. Determine the value of forecasting ($F_{t+m}$)

$$F_{t+m} = a_t + b_t(m)$$  \hspace{1cm} (5)
Description:

\[ m = \text{Number of future periods that are predicted} \]

\[ S'_t = \text{Eksponential smoothing Single in t period} \]

\[ S''_t = \text{Eksponential smoothing Double in t period} \]

\[ \alpha = \text{Exponential smoothing parameters} \quad (0 < \alpha < 1) \]

\[ a_t, b_t = \text{Smoothing constant} \]

\[ F_{t+m} = \text{Forecasting result for the next m period} \]

To use this equation, the value of \[ S'_{t-1} \] and \[ S''_{t-1} \] must be known. But at time \( t = 1 \), these values are not available. Because the value of this value should be determined at the beginning of the period.

2.5 Forecasting Accuracy

Forecasting accuracy is a fundamental thing in forecasting, namely how to measure the suitability of a certain forecasting method for a given data set. Accuracy is seen as a refusal criterion to choose a forecasting method. In time series modeling from past data, it is possible to predict situations that will occur in the future, to test the truth of this prediction, accuracy is used. Some of the criteria used to test the accuracy of the forecast are:

a. ME (Mean Error)

\[ ME = \sum_{t=1}^{n} \frac{e_t}{n} \quad (6) \]

b. MSE (Mean Square Error)

\[ MSE = \sum_{t=1}^{n} \frac{e_t^2}{n} \quad (7) \]

c. MAE (Mean Absolute Error)

\[ MAE = \sum_{t=1}^{n} \frac{|e_t|}{n} \quad (8) \]

d. MPE (Mean Percentage Error)

\[ MPE = \frac{\sum_{t=1}^{n} p e_t}{n} \quad (9) \]
e. **SSE (Sum Square Error)**

\[ SSE = \sum_{t=1}^{n} e_t^2 \]  

(10)

d. **MAPE (Mean Absolute Percentage Error)**

\[ MAPE = \frac{\sum_{t=1}^{n} |P_{E_t}| \big/ n}{n} \]  

(11)

The measure of forecasting accuracy is used to evaluate the value of the forecasting parameters. If \(X_t\) is the actual data for the period \(t\) and \(F_t\) is the forecast (or the value of a match) for the same period, then the error is defined as follows:

\[ e_t = X_t - F_t \]  

(12)

If there is a value of observation and predictions for \(n\) period time, there will be \(n\) errors. In this study to determine the size of the forecasting error, the author uses the relative error measure Mean Absolute Percentage Error (MAPE).

2.6 **Mean Absolute Percentage Error (MAPE)**

MAPE or absolute percentage error median value is the average of the overall percentage of error (difference) between the actual data with the value forecasting for MAPE calculating formula (13) is as follows:

\[ MAPE = \frac{\sum_{t=1}^{n} |P_{E_t}| \big/ n}{n} \]  

(13)

<table>
<thead>
<tr>
<th>Table 1 Value MAPE for the Evaluation of Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value MAPE</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>MAPE ≤ 10%</td>
</tr>
<tr>
<td>10% &lt; MAPE ≤ 20%</td>
</tr>
<tr>
<td>20% &lt; MAPE ≤ 50%</td>
</tr>
<tr>
<td>MAPE &gt; 50%</td>
</tr>
</tbody>
</table>

percentage of error is an error percentage of a forecasting:

\[ PE_t = \left( \frac{X_t - F_t}{X_t} \right) \times 100\% \]  

(14)

Description:

\(e_t\) = error in the period to-\(t\)
\[ X_t = \text{actual data for the period to-} t \]
\[ F_t = \text{the value of the forecast period to-} t \]
\[ n = \text{number of times periode} \]

### 2.7 Research Flow Chart

![Research Flow Chart](figure2.png)

**Figure 2.** Research Step
3. Result and Discussion

3.1 Data Analysis

In this study the data used for forecasting is data horticultural crop production amount of drug (medicinal) in North Sumatra, the data obtained from the Badan Pusat Statistik from 2007 - 2019. The data have been magnified by as follows:

**Table 2** Production of medicinal plants by type of crop year 2007-2011

<table>
<thead>
<tr>
<th>No</th>
<th>Plant Type</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ginger</td>
<td>3.777.224</td>
<td>5.820.524</td>
<td>8.555.608</td>
<td>5.692.250</td>
<td>4.718.540</td>
</tr>
<tr>
<td>2</td>
<td>Galangal</td>
<td>1.152.141</td>
<td>1.248.436</td>
<td>1.029.076</td>
<td>1.492.640</td>
<td>1.196.467</td>
</tr>
<tr>
<td>3</td>
<td>Aromatic Ginger</td>
<td>900.156</td>
<td>939.603</td>
<td>833.580</td>
<td>605.312</td>
<td>451.913</td>
</tr>
<tr>
<td>4</td>
<td>Turmeric</td>
<td>3.225.818</td>
<td>4.081.089</td>
<td>3.520.787</td>
<td>5.613.600</td>
<td>4.218.350</td>
</tr>
<tr>
<td>5</td>
<td>Bitter Ginger</td>
<td>158.193</td>
<td>119.815</td>
<td>404.679</td>
<td>424.915</td>
<td>63.662</td>
</tr>
<tr>
<td>6</td>
<td>Curcuma</td>
<td>151.646</td>
<td>156.767</td>
<td>171.026</td>
<td>146.565</td>
<td>55.590</td>
</tr>
<tr>
<td>7</td>
<td>Curcuma Aeruginosa</td>
<td>50.551</td>
<td>49.641</td>
<td>35.653</td>
<td>2.999</td>
<td>1.795</td>
</tr>
<tr>
<td>8</td>
<td>Fingerroot</td>
<td>4.868</td>
<td>14.050</td>
<td>17.078</td>
<td>7.474</td>
<td>3.579</td>
</tr>
<tr>
<td>9</td>
<td>Sweetroot</td>
<td>152.849</td>
<td>49.259</td>
<td>96.604</td>
<td>188.884</td>
<td>105.834</td>
</tr>
<tr>
<td>10</td>
<td>Cardamom</td>
<td>154.448</td>
<td>184.154</td>
<td>189.622</td>
<td>35.056</td>
<td>2.212</td>
</tr>
<tr>
<td>11</td>
<td>Noni</td>
<td>57.381</td>
<td>95.574</td>
<td>125.819</td>
<td>111.806</td>
<td>44.498</td>
</tr>
<tr>
<td>12</td>
<td>Crown of God</td>
<td>-</td>
<td>15.123</td>
<td>70.164</td>
<td>85.971</td>
<td>63.994</td>
</tr>
<tr>
<td>13</td>
<td>Obnoxious</td>
<td>1.432</td>
<td>1.200</td>
<td>2.587</td>
<td>3.596</td>
<td>3.713</td>
</tr>
<tr>
<td>15</td>
<td>Aloe Vera</td>
<td>-</td>
<td>2.244</td>
<td>8.456</td>
<td>11.796</td>
<td>7.100</td>
</tr>
</tbody>
</table>

**Table 3** Production of medicinal plants by type of crop year 2012-2016

<table>
<thead>
<tr>
<th>No</th>
<th>Plant Type</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Galangal</td>
<td>895.393</td>
<td>2.373.388</td>
<td>1.184.701</td>
<td>956.970</td>
<td>729.991</td>
</tr>
<tr>
<td>3</td>
<td>Aromatic Ginger</td>
<td>249.770</td>
<td>238.444</td>
<td>346.683</td>
<td>367.775</td>
<td>315.861</td>
</tr>
<tr>
<td>4</td>
<td>Turmeric</td>
<td>4.469.263</td>
<td>9.384.621</td>
<td>5.960.304</td>
<td>3.894.542</td>
<td>1.913.923</td>
</tr>
<tr>
<td>5</td>
<td>Bitter Ginger</td>
<td>73.749</td>
<td>38.732</td>
<td>26.293</td>
<td>22.687</td>
<td>29.714</td>
</tr>
<tr>
<td>6</td>
<td>Curcuma</td>
<td>238.027</td>
<td>294.417</td>
<td>161.575</td>
<td>121.255</td>
<td>63.677</td>
</tr>
<tr>
<td>7</td>
<td>Curcuma Aeruginosa</td>
<td>3.495</td>
<td>17.679</td>
<td>15.617</td>
<td>8.518</td>
<td>4.338</td>
</tr>
<tr>
<td>8</td>
<td>Fingerroot</td>
<td>5.537</td>
<td>21.397</td>
<td>19.828</td>
<td>17.952</td>
<td>6.693</td>
</tr>
<tr>
<td>9</td>
<td>Sweetroot</td>
<td>56.080</td>
<td>105.032</td>
<td>20.165</td>
<td>31.290</td>
<td>9.691</td>
</tr>
</tbody>
</table>
**Table 4.** Production of medicinal plants by type of crop year 2017-2019

<table>
<thead>
<tr>
<th>No</th>
<th>Plant Type</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ginger</td>
<td>7,263,534</td>
<td>5,452,774</td>
<td>2,814,772</td>
</tr>
<tr>
<td>2</td>
<td>Galangal</td>
<td>1,250,007</td>
<td>432,713</td>
<td>750,052</td>
</tr>
<tr>
<td>3</td>
<td>Aromatic Ginger</td>
<td>212,238</td>
<td>167,455</td>
<td>106,459</td>
</tr>
<tr>
<td>4</td>
<td>Turmeric</td>
<td>4,565,882</td>
<td>2,580,257</td>
<td>1,125,698</td>
</tr>
<tr>
<td>5</td>
<td>Bitter Ginger</td>
<td>15,539</td>
<td>11,105</td>
<td>20,138</td>
</tr>
<tr>
<td>6</td>
<td>Curcuma</td>
<td>50,502</td>
<td>50,553</td>
<td>50,285</td>
</tr>
<tr>
<td>7</td>
<td>Curcuma Aeruginosa</td>
<td>506</td>
<td>1,637</td>
<td>18,436</td>
</tr>
<tr>
<td>8</td>
<td>Fingerroot</td>
<td>993</td>
<td>1,185</td>
<td>3,734</td>
</tr>
<tr>
<td>9</td>
<td>Sweetroot</td>
<td>1,612</td>
<td>1,736</td>
<td>6,768</td>
</tr>
<tr>
<td>10</td>
<td>Cardamom</td>
<td>46,071</td>
<td>22,910</td>
<td>42,397</td>
</tr>
<tr>
<td>11</td>
<td>Noni</td>
<td>3,792</td>
<td>14,592</td>
<td>47,416</td>
</tr>
<tr>
<td>12</td>
<td>Crown of God</td>
<td>10,911</td>
<td>43,548</td>
<td>75,580</td>
</tr>
<tr>
<td>13</td>
<td>Obnoxious</td>
<td>352</td>
<td>927</td>
<td>3,601</td>
</tr>
<tr>
<td>14</td>
<td>Bitter</td>
<td>1,863</td>
<td>1,480</td>
<td>6,061</td>
</tr>
<tr>
<td>15</td>
<td>Aloe Vera</td>
<td>-</td>
<td>4,302</td>
<td>5,380</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
<th>14,169,675</th>
<th>23,123,690</th>
<th>22,382,726</th>
</tr>
</thead>
</table>

**Table 5.** Total production of medicinal plants in North Sumatra in 2007 until 2019

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Production (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>9,798,874</td>
</tr>
<tr>
<td>2008</td>
<td>12,794,375</td>
</tr>
<tr>
<td>2009</td>
<td>15,082,696</td>
</tr>
<tr>
<td>2010</td>
<td>14,430,922</td>
</tr>
<tr>
<td>2011</td>
<td>10,941,594</td>
</tr>
<tr>
<td>2012</td>
<td>14,169,675</td>
</tr>
<tr>
<td>2013</td>
<td>23,123,690</td>
</tr>
</tbody>
</table>
Forecasting of method Double Exponential Smoothing Brown with used obtained a smoothing parameter that is \( \alpha \) to smooth the actual data time series. In determining the smoothing parameter \( \alpha \) whose magnitude is \( 0<\alpha<1 \) by trial and error or guesswork produces Mean Absolute Percentage Error (MAPE) minimum.

### 3.2 Method Analysis

In solving the problem of the method, Double Exponential Smoothing Brown there are several steps that are used according to the specified formula, namely by using data on the amount of production of medicinal horticultural plants (biopharmaceuticals) in North Sumatra from 2007–2019 which can be seen in table 5.

From Table 5, forecasts can be made about the amount of production of medicinal horticultural plants (biopharmaceuticals) in the coming year. Double Exponential Smoothing Brown is also a method of linear equations of the parameters of Brown is set like the following:

**Medicinal Plants Production Amount Forecasting with parameter \( \alpha = 0.1 \):**

**For the year to-1 (2007):**

\[ S'_t \] = Specified amount of medicinal plant production per year (2007) which is 9,798,874 kg.

\[ S''_t \] = Determined by the amount of production of biopharmaceutical plants for year (2007) which is 9,798,874 kg, because for t-1 it has not been obtained.

\[ a_t \] = Undefined.

\[ b_t \] = Undefined.

**For year 2 (2008):**

\[ X_2 = 12.794.375 \]
1. Determine the value of smoothing first $S_t'$

$$S_t' = \alpha X_2 + (1 - \alpha)S_{t-1}'$$

$$= 0.1 (12.794.375) + (0.9) (9.798.874)$$

$$= 1.279.437.5 + 8.818.986.6$$

$$= 10.098.424.1$$

2. Determining the value of smoothing a second $S_t''$

$$S_t'' = \alpha S_t' + (1 - \alpha)S_{t-1}''$$

$$= 0.1 (10.098.424,1) + (0.9) (9.798.874)$$

$$= 1.009.842,41 + 8.818.986,6$$

$$= 9.828.829,01$$

3. Determining the value of a constant period $t (at)$

$$a_t = 2S_t' - S_t''$$

$$= 2 (10.098.424,1) - 9.828.829,01$$

$$= 10.368.019,19$$

4. Determine the smoothing constant value ($bt$)

$$b_t = \frac{\alpha}{(1-\alpha)}(S_t' - S_t'')$$

$$= \frac{0.1}{0.9} (10.098.424,1 - 9.828.829,01)$$

$$= 29.955,01$$

5. Determining the forecast value ($F_{t+m}$)

To find the value of $F_{t+m}$ cannot be determined because the values of $a_t$ and $b_t$ have been determined in the previous year. The value of $F_{t+m}$ can be found in the 3rd year.
For the 3rd year (2009)

\[ X_3 = 15.082.696 \]

1. Determine the value Smoothing first \( S'_t \)

\[ S'_t = \alpha X_3 + (1 - \alpha)S'_{t-1} \]

\[ = 0,1 \times (15.082.696) + (0,9) \times (10.098.424,1) \]

\[ = 1.508.269,6 + 9.088.581,69 \]

\[ = 10.596.851,29 \]

2. Determine value Smoothing second \( S''_t \)

\[ S''_t = \alpha S'_t + (1 - \alpha)S''_{t-1} \]

\[ = 0,1 \times (10.596.851,29) + (0,9) \times (9.828.829,01) \]

\[ = 1.059.685,129 + 8.845.946,109 \]

\[ = 9.905.631,238 \]

3. Determining the value of a constant period \( t \) (at)

\[ a_t = 2S'_t - S''_t \]

\[ = 2 \times (10.596.851,29) - 9.905.631,238 \]

\[ = 11.288.071,342 \]

4. Determine the smoothing constant value \( b_t \)

\[ b_t = \frac{\alpha}{(1 - \alpha)} (S'_t - S''_t) \]

\[ = \frac{0,1}{0,9} (10.596.851,29 - 9.905.631,238) \]

\[ = 76.802,228 \]

5. Determine the forecast value \( F_{t+m} \) The 3rd year forecast with \( m=1 \)

\[ F_{2008+1} = a_{2008} + b_{2008} (m) \]

\[ = 10.368.019,19 + 29.955,01 \]
The value of $e_t$ for 2009 are:

$$e_{2009} = X_{2009} - F_{2009}$$

$$= 15.082.696 - 10.397.974,2$$

$$= 4.684.721,8$$

Percentage error 2009 are:

$$PE_t = \left( \frac{X_t - F_t}{X_t} \right) \times 100\%$$

$$= \left( \frac{15.082.696 - 10.397.974,2}{15.082.696} \right) \times 100\%$$

$$= 31\%$$

To determine the level of error is:

$$MAPE = \frac{\sum_{t=1}^{n} |PE_t|}{n}$$

$$= \frac{490.6}{11}$$

$$= 44,60\%$$

Where the number of $n$ used is $n = 11$ because to find the value of $F_{t+m}$ it cannot be determined because the values of $a_t$ and $b_t$ have been determined in the previous year. The value of $F_{t+m}$ can be found in the 3rd year. Using the same calculation, it can be determined value Double Exponential Smoothing and forecast value that will come to $\alpha = 0.20$ up to $\alpha = 0.90$.

### 3.3 Selection of parameters Best $\alpha$.

In this study the selection of parameter $\alpha$ best are selected based on the value of Absolute Mean Percentage Error (MAPE), the smallest value predetermined is 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, and 0.90. Results calculation of Percentage Mean Absolute Error (MAPE), the smallest of the parameters $\alpha=0.10$ to $\alpha=0.90$ can be seen in Table 5 as follows:
Table 6. MAPE value for the parameter $\alpha = 0.10$ to the $\alpha = 0.90$

<table>
<thead>
<tr>
<th>The parameter $\alpha$</th>
<th>Mean Absolute Percentage Error (MAPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>44.6%</td>
</tr>
<tr>
<td><strong>0.20</strong></td>
<td><strong>25.2%</strong></td>
</tr>
<tr>
<td>0.30</td>
<td>39.0%</td>
</tr>
<tr>
<td>0.40</td>
<td>33.4%</td>
</tr>
<tr>
<td>0.50</td>
<td>32.3%</td>
</tr>
<tr>
<td>0.60</td>
<td>32.1%</td>
</tr>
<tr>
<td>0.70</td>
<td>31.7%</td>
</tr>
<tr>
<td>0.80</td>
<td>33.9%</td>
</tr>
<tr>
<td>0.90</td>
<td>34.4%</td>
</tr>
</tbody>
</table>

It is known that the value of parameter $\alpha$ the value percentage Mean Absolute Error (MAPE), the smallest is the value of $\alpha = 0.20$. Table 6 shows value of the parameter $\alpha$ the smallest at $\alpha= 0.20$ with MAPE value by 25.2%. And to assure value of the parameter $\alpha$ the relative that best writers determines the return value parameter $\alpha$ with 2 digits behind the decimal are 0.21, 0.22, 0.23, 0.24, 0.25, 0.26, 0.27, 0.28, 0.29.

Table 7. MAPE value for parameter $\alpha = 0.21$ to the $\alpha = 0.29$

<table>
<thead>
<tr>
<th>The parameter $\alpha$</th>
<th>Mean Absolute Percentage Error (MAPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.21</td>
<td>44.6%</td>
</tr>
<tr>
<td>0.22</td>
<td>44.1%</td>
</tr>
<tr>
<td>0.23</td>
<td>43.5%</td>
</tr>
<tr>
<td><strong>0.24</strong></td>
<td><strong>25.1%</strong></td>
</tr>
<tr>
<td>0.25</td>
<td>42.3%</td>
</tr>
<tr>
<td>0.26</td>
<td>41.7%</td>
</tr>
<tr>
<td>0.27</td>
<td>41.0%</td>
</tr>
<tr>
<td>0.28</td>
<td>40.4%</td>
</tr>
<tr>
<td>0.29</td>
<td>39.7%</td>
</tr>
</tbody>
</table>

Table 7 shows that value of the parameter $\alpha$ the smallest is $\alpha= 0.24$ with MAPE value of 25.1%. The best MAPE value that has been obtained by trial and error, then forecasting can then be done using the method Double Exponential Smoothing Brown.
3.4 Horticultural Crop Production Forecasting Total Medicinal
After calculating the value of smoothing first, second smoothing value, the value of \( a_t \) and the value of \( b_t \) by using the value of \( \alpha = 0.24 \) then the next can be determined horticultural crop production forecast amount of medicinal in North Sumatra.

So to determine forecasting in the coming year, the formula \( F_{t+m} = a_t + b_t(m) \). The values of \( a_t \) and \( b_t \) taken from 2019. Because the years to be forecast are 2020 and 2021, the number of future forecasts is determined by the number of previous years. The following is the process of completing forecasts for 2020 and 2021.

**a. Forecast for 2020 (m=1)**

\[
F_{t+m} = a_t + b_t (m)
\]

\[
F_{2019+1} = a_{2019} + b_{2019} \quad (1)
\]

\[
F_{2020} = 9.128.603,21 + (-674.595,97)
\]

\[
F_{2020} = 8.454.007,24
\]

Based on the forecasting results, the number of production of medicinal horticultural plants (bio-pharmaceuticals) that will be forecasted in 2020 is 8,454,007.24 kg.

**b. Forecast for 2021 (m=2)**

\[
F_{t+m} = a_t + b_t (m)
\]

\[
F_{2019+2} = a_{2019} + b_{2019} \quad (2)
\]

\[
F_{2021} = 9.128.603,21 + (-674.595,97) \quad (2)
\]

\[
F_{2021} = 7.779.411,27
\]

Based on the forecast, the number of drug horticultural crop production (biofarmaka) to be foreseen in 2021 is a total of 7,779,411.27 kg.
Figure 2: Graph Double Exponential Smoothing Brown with $\alpha = 0.24$ in horticultural crop production data on the number of drug (medicinal) in North Sumatra.

From Figure 2 above, it can be seen that the forecasting of the production of medicinal horticultural plants (biopharmaceuticals) in North Sumatra in 2020 has increased and in 2021 it has decreased.

4. Conclusions and Future Research

4.1. Conclusion

Based on the analysis and discussion that has been done can be that parameter $\alpha$ best obtained for forecasting the amount of horticultural production plants drug (medicinal) in North Sumatra from 2007 until 2019 is $\alpha = 0.24$ with MAPE by 25.1% with the production of medicinal horticultural plants (biopharmaceuticals) in 2020 amounting to 8,454,007.24 kg, and in 2021 it will be 7,779,411.27 kg.

4.2 Future Research

For further research in analyzing forecasting, other variables can be added that support forecasting the amount of production of medicinal horticultural plants (biopharmaceuticals), such as factors that affect production levels so as to maximize the work of this system analysis. Suggestions given for system development in future research is that this research is only in the scope of Sumatra Province. For further research, it is hoped that it will be carried out in various provinces.
REFERENCES


