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Prediction of the Amount of Areca Nut Plantation Production in Riau Province Using the Single Exponential Smoothing

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Abstract - *Data in this study was obtained from the Riau Provincial Plantation Office. This study aims to forecast areca nut plantation production in Riau Province in 2023. The data used is data obtained from the Riau Provincial Plantation Office in 2011-2022. Betel seeds are generally grown to be used for their seeds, areca nuts that are traded, especially those that have been dried, in a whole (round), split, and there is also by boiling to get the quality of areca nuts to be exported. Betel seeds have been used since hundreds of years ago as one of the mixtures of people eating betel nut in addition to gambier and lime. In addition, areca nuts are also used as industrial raw materials such as fabric dyes and medicines. The separation of areca nuts is carried out by splitting them using a knife or machete, drying them in the sun, then prying and drying them before selling them to collectors. The purpose of this study is to find out the results of predicting the number of areca nut production in Riau Province and find out the results of forecasting the number of areca nut production in Riau Province in 2023. The method used in this study is Single Exponential Smoothing. Based on the results of data processing from 2011 to 2022, the results of this forecast have a MAPE value with α = 0.7 in 2023 of 7.095371%. The results show that the Single Exponential Smoothing method has a good level of accuracy to predict the amount of areca nut production in Riau Province.*

Keywords: *MAPE, Pinang, Prediction, Single Exponential Smoothing.*

1. Introduction

Riau Province is one of the agrarian regions since more than fifty years ago, where some of the residents work as farmers and planters. One of the forms of plantation production in Riau Province is areca nut plantation [1]. The areca nut is generally grown for the use of the seeds, the separation between the seeds and the areca nut shell is carried out manually or by using a areca nut peeler or splitter that has been developed. The betel nuts that are traded, especially those that have been dried, are whole, split, and there is also by boiling to get the quality of areca nuts to be exported [2]. Betel seeds have been used since hundreds of years ago as one of the mixtures of people eating betel nut in addition to gambier and lime. In addition, areca nuts are also used as industrial raw materials such as fabric dyes and medicines. The separation of areca nuts is carried out by splitting them using a knife or machete, drying them in the sun, then prying and drying them before selling them to collectors. The solution to the problem of the amount of areca nut plantation production can be done using the Single Exponential Smoothing (SES) method. This is because forecasting with SES is forecasting by processing past data patterns and then using it to forecast production data in the future. SES works by capturing patterns from historical data to project future data [3].

A 2017 study by [1] regarding the factors affecting the production of areca nut farmers in Sungai Gebar Barat Village, Kuala Betara District, Tanjung Jabung Barat Regency obtained that the average age of areca nut farmers in Sungai Gebar Barat Village is 42 years old. The average number of areca nut farmer family members is 4 people. The education level is dominated by high school education. The average areca nut production of farmers in Sungai Gebar Barat Village is 256.94 kg per month. From the regression results, it was found that land area and labor had a significant positive influence on areca nut production, while production costs and prices had no significant effect. Furthermore, by [4] in 2019 regarding the Comparison of Exponential Smoothing Methods for Forecasting the Sales of 3 Processed Meat Products of Kampung Chicken (Case Study: Mama Arka Fried Chicken) it was obtained that forecasting with Triple Exponential Smoothing (TES) produced the best forecasting for 3 products, with the smallest MAE value obtained in soy sauce grilled chicken products of 2.45, so it can be concluded that the most accurate method for product forecasting can be concluded Processed free-range chicken meat is the Triple Exponential Smoothing (TES) method.

Then by [5] in 2021 regarding the Single Exponential Smoothing Method in Forecasting the Number of E-KTP Makings (Case Study: Marpoyan Damai District) it was obtained that the forecasting value of the number of e-KTP making in 2020 using the single exponential smooting method with an alpha of 0.1 of 9550 made e-KTP. So, from the results of the author's observations, it was found that in 2020 the number of e-KTP purchases decreased from the previous year. The next research by [6] in 2022 regarding Drug Inventory Forecasting using the Single Exponential Smoothing Method by tracking the alpha value randomly (trial) to obtain the alpha that has the least error by searching using the MSE (Mean Square Error) conformity method so that store owners can easily determine the number of drug purchases to maximize drug inventory.

Furthermore, research by [7] in 2023 regarding the Number of Visitors Forecasting System at PT. Garuda Plaza Hotel uses the Single Exponential Smoothin method. The results of the analysis using the SES method estimate the number of visitors in March 2022 at 5631.30. However, the Mean Square Error (MSE) value of the forecast for alpha 0.3 shows an error rate of 57.30%. It is hoped that with this new planned system, PT. Garuda Plaza Hotel Medan can increase efficiency in collecting guest data and forecast the number of visitors more accurately and effectively.

2. Research Methods

Conduct literature studies; Literature study is carried out by studying literature related to practical work materials. Data collection; Data collection was carried out at the Riau Provincial Plantation Office and the data collected was a recap of areca nut plantation production data provided by the Riau Provincial Plantation Office from 2011 to 2022. Data Processing; In this study, the Single Exponential Smoothing method is used in existing data processing.

2.1. Definition and Purpose of Forecasting

Forecasting is a picture of the company's condition in the future. Forecasting is not always 100% accurate because the future contains the problem of uncertainty, but with the right selection of methods forecasting can be done with a small margin of error [8.] Forecasting aims to predict, project or estimate the magnitude of uncertain events in the future. Forecasting is always made to reduce the influence of this uncertainty on a problem. In other words, forecasting aims to obtain forecasting that can further reduce forecasting errors which are usually measured by Mean Squared Error (MSE), Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE) [9].

2.2 Types of Forecasting

a. Short-term forecasting This forecast has a time span of up to 1 year, but generally less than 3 months. Used for purchasing planning, job scheduling, workforce level, job assignment and production level.
b. Medium-term forecasting The forecast ranges from 3 months to 3 years. Useful in sales planning, production planning and budgeting, cash budgeting, and analysis of operating plan variations.
c. Generally 3 years or more in its time span, long-term forecasting is used in planning for new production, capital expenditures, the location of facilities or expansions, and research and development.

2.3 Single Exponential Smoothing

Single Exponential Smoothing (SES) is a development of the single moving averages method. To obtain information on the prediction of the number and accuracy can be seen from the smallest error value. The Single Exponential Smoothing (SES) method is a procedure for continuous improvement in the prediction of the latest observation objects. In this method, the prediction is carried out by repeating the calculation continuously using the latest data. Each data is weighted, the newer data is given more weight. The weight contained in the SES method is the alpha weight (α) value. The alpha function here is as a smoothing parameter value which has a value range from 0 to 1. The magnitude (α) of alpha is determined randomly (trial and error) until (α) alpha is found that produces the smallest forecast error.

In the Single Exponential Smoothing method, the parameters given to the existing data are α for the latest data, α (1- α) for older data, α $(1-\alpha)^2$ for older data, and so on. The magnitude of α is between 0 and 1. Mathematically, the magnitude of forecasting equations is:

$$S_{t+1} = \alpha X_1 + (1-\alpha) S_t$$

Information:

S_t : Forecast for the period t

X_t : The real value of the period t

S_{t+1} : Forecast for the period t

Α : Smoothing constant

Thus, it can be said that the forecast in the future period is the previous forecast plus α (alpa) determined by trial and error until the smallest error. The magnitude of α is between 0 and 1. This method is more suitable for forecasting data that fluctuates randomly. α is the alpha value (0.1 to 0.9 to determine the smallest error value). After the calculation of the prediction value. To get the alpha value, with the formula:

$$\alpha = \frac{2}{n+1}$$

where:

n : Number of time periods

2.4. Measuring Forecasting Errors

Then the measurement of the accuracy of the forecast results is to determine the effectiveness of the forecast. In carrying out accuracy in forecasting, there are several algorithms that can be used in evaluating the results of accurate calculations on forecasting in determining prediction errors, namely Mean Squared Error (MSE), Mean Absolute Deviation (MAD), and Mean Absolute Percentage Error (MAPE). In this study, the calculation of the accuracy of forecasting in determining prediction errors is the Mean Absolute Percentage Error (MAPE). MAPE is a relative measure of error. MAPE is usually more meaningful than MAD because MAPE expresses the percentage of error of forecasting results against actual demand over a given period that will provide information about the percentage of errors too high or too low. But here will be added Mean Error (ME) as the first reference to find the error value.

1. ME or Average Error Score

$$ME = \frac{\sum Aktual - Peramalan}{n}$$

2. MAD or Absolute Error Average Deviation Value

$$MAD = \frac{\sum|Aktual - Peramalan|}{n}$$

3. MAPE or Absolute Percentage Error Average Value

$$MAPE = \frac{\sum(|Aktual - Peramalan|)/Aktual)*100}{n}$$

is the number of prediction periods involved, is the forecast nF_t in the period, is the actual data in the period. The MAPE value that has been obtained from the calculation results can be analyzed, whether a forecast has good performance. The smaller the MAPE value means that the interpretation value is closer to the actual value, or the method chosen is the best method. Forecasting ability is very good if it has a MAPE value of less than 10% and has good forecasting ability if the MAPE value is less than 20%.$tA_t t$

3. Results and Discussion

3.1 Data Description

The data needed in this study was obtained through a data capture of the plantation office which contains historical data on annual production for 12 years (2011-2022) from areca nut plantation production data in Riau Province, where the data are as follows.

Table 1. Pinang Plantation Production Data 2011-2022

YEAR	CURRENT
2011	10.700
2012	10.818
2013	8.761
2014	8.598
2015	9.825
2016	10.053
2017	10.493
2018	10.536
2019	11.735
2020	12.192
2021	12.296
2022	11.255

Source: Riau Provincial Plantation Office

From the data above, it will be used as a graph to be analyzed based on periodic data.

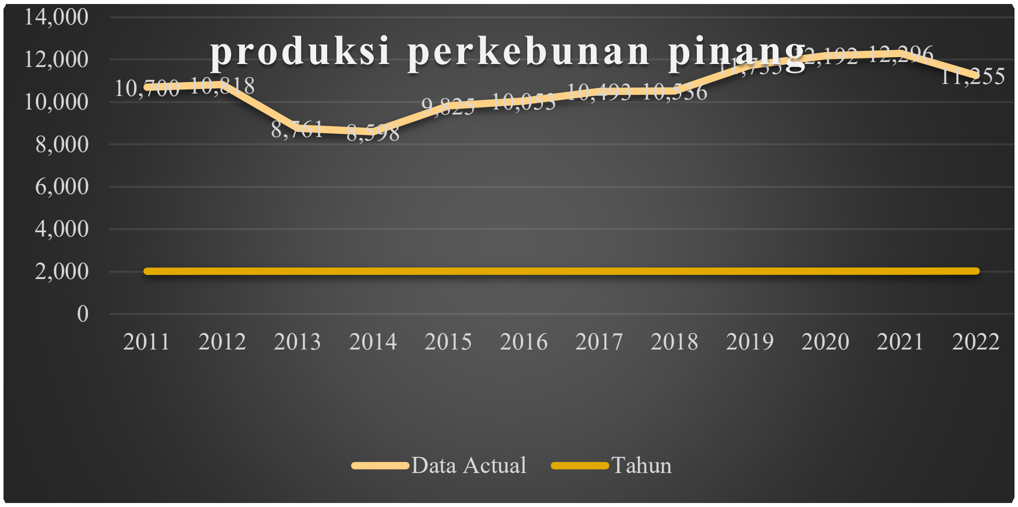

Figure 1. Betel Plantation Production Chart 2011-2022

3.2 Data Analysis and Discussion

From the available data, it is then processed with Single Exponential Smoothing. In data processing using Single Exponential Smoothing, forecasting is carried out with one smoothing only, using the formula:

$$S_{t+1} = \alpha X_1 + (1 - \alpha) S_t$$

Based on, = New Forecast, = Previous Forecast, = Smoothing Constant and = Actual demand of the previous period. Forecasting $S\ t + 1 \alpha X_1$ is also carried out by minimizing the difference (error) in the data above. Minimization is carried out by manual method by entering a value of up to 0.9. By minimizing $\alpha = 0{,}1$errors, the most optimal forecasting results will be obtained. The error value in question is the calculation value of MAD, MAPE, MSE. The most optimal forecasting analysis results with the least error are obtained by entering the values, and $\alpha = 0{,}3 \alpha = 0{,}5 \alpha = 0{,}7$. The following is the result of the calculation by entering the value α = 0.3 and the value $1 - \alpha = 0.7$:

Table 2. Forecast Data for Pinang Plantation Production with α = 0.3

No (X)	Period	And	Y'	MAD	MSE	MAPE
1	2011	10.700	#N/A	#N/A	#N/A	#N/A
2	2012	10.818	10.700	118	13.924	0,010908
3	2013	8.761	10735,4	1974,4	3.898.255	0,225362
4	2014	8.598	10143,08	1545,08	2.387.272	0,179702
5	2015	9.825	9679,556	145,444	21.154	0,014803
6	2016	10.053	9723,189	329,8108	108.775	0,032807
7	2017	10.493	9822,132	670,8676	450.063	0,063935
8	2018	10.536	10023,39	512,6073	262.766	0,048653
9	2019	11.735	10177,17	1557,825	2.426.819	0,13275
10	2020	12.192	10644,52	1547,478	2.394.687	0,126926
11	2021	12.296	11108,77	1187,234	1.409.525	0,096555
12	2022	11.255	11464,94	209,936	44.073	0,018653
13	2023	?	11401,96			
Sum						**0,951054**
						95,1054
						7,92545

a. Forecasting using α = 0. 3
   $S11$ = 10.700;

$S12 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (10.818) + (1 − 0,3) 10.700
= 10735,4;

$S13 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (8.761) + (1 − 0,3) 10735,4
= 10143,08;

$S14 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (8.598) + (1 − 0,3) 10143,08
= 9679,556;

$S15 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (9.825) + (1 − 0,3) 9679,556
= 9723,189;

$S16 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (10.053) + (1 − 0,3) 9723,189
= 9822,132;

$S17 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (10.493) + (1 − 0,3) 9822,132
= 10023,39;

$S18 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (10.536) + (1 − 0,3) 10023,39
= 10177,17;

$S19 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (11.735) + (1 − 0,3) 10177,17
= 10644,52;

$S20 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (12.192) + (1 − 0,3) 10644,52
=11108,77

$S21 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (12.296) + (1 − 0,3) 11108,77
= 11464,94;

$S22 = \alpha\, Xt + (1 - \alpha)\, S1$
= (0,3) (11.253) + (1 − 0,3) 11464,94
= 11401,96.

Based on the data above, several things can be explained, namely, the period is the year of production, Y is the actual data per year and Y' is the forecast for the next year. Then MAD is the average value of the abs error value obtained from the data Y (actual) minus the forecast result (Y'). MAPE is the average percentage of error values obtained from data Y (actual) minus forecast results (Y') and then divided by the number of years (period). MSE is the average value of the square error obtained from the data Y (actual) minus the forecast result (Y') and then quadrathed. Meanwhile, the graph of areca nut plantation production forecasting is as follows:

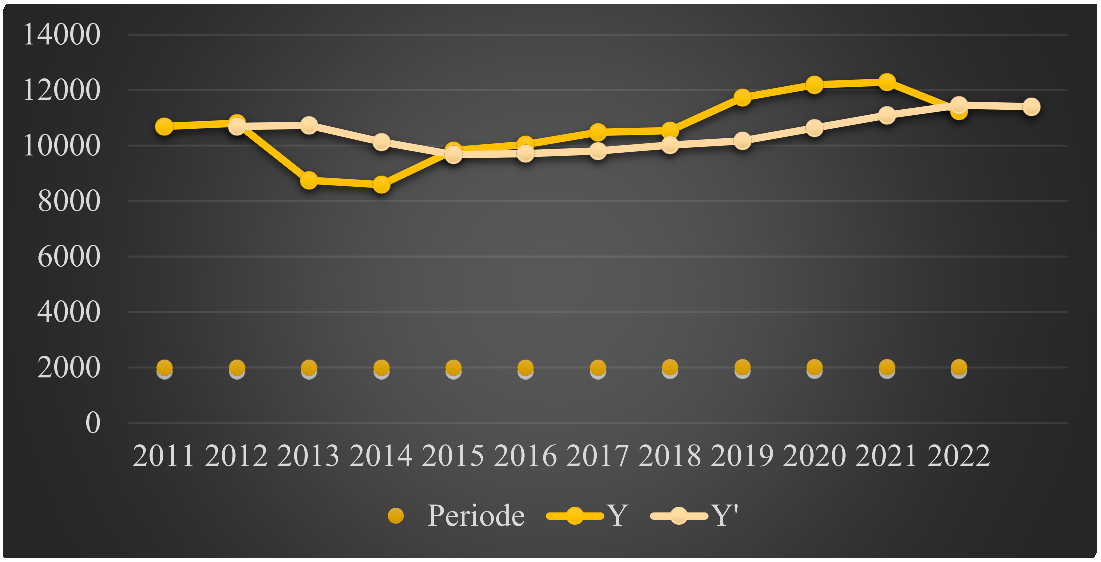

Figure 2. Chart of Pinang Plantation Production with α = 0.3

The dark blue line is a graph of the actual data per year, while the light blue line is a graph of the forecast value. The following is the result of the calculation by entering the value and value $1 - \alpha = 0{,}5\ \alpha = 0.5$:

Table 3. Forecast Data for Pinang Plantation Production with α = 0.5

No (X)	Period	And	Y'	MAD	MSE	MAPE
1	2011	10.700	#N/A	#N/A	#N/A	#N/A
2	2012	10.818	10.700	118	13.924	0,010908
3	2013	8.761	10759	1998	3.992.004	0,228056
4	2014	8.598	9760	1162	1.350.244	0,135148
5	2015	9.825	9179	646	417.316	0,065751
6	2016	10.053	9502	551	303.601	0,05481
7	2017	10.493	9777,5	715,5	511.940	0,068188
8	2018	10.536	10135,25	400,75	160.601	0,038036
9	2019	11.735	10335,63	1399,375	1.958.250	0,119248
10	2020	12.192	11035,31	1156,688	1.337.926	0,094873
11	2021	12.296	11613,66	682,3438	465.593	0,055493
12	2022	11.255	11954,83	699,8281	489.759	0,062179
13	2023	?	11604,91			
Sum						0,932689
						93,26894
						7,772412

b. Forecasting using α = 0.5

$S11 = 10.700;$

$S12 = \alpha\, Xt + (1 - \alpha)\, S1$

$= (0{,}5)\,(10.818) + (1 - 0{,}5)\, 10.700$

$= 10759;$

$S13 = \alpha\, Xt + (1 - \alpha)\, S1$

$= (0{,}5)\,(8.761) + (1 - 0{,}5)\, 10759$

$= 9760;$

$S14 = \alpha\, Xt + (1 - \alpha)\, S1$

$= (0{,}5)\,(8.598) + (1 - 0{,}5)\, 9760$

$= 9179;$

$S15 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (9.825) + (1 - 0{,}5)\ 9179$

$= 9502;$

$S16 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (10.053) + (1 - 0{,}5)\ 9502$

$= 9777{,}5;$

$S17 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (10.493) + (1 - 0{,}5)\ 9777{,}5$

$= 10135{,}25;$

$S18 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (10.536) + (1 - 0{,}5)\ 10135{,}25$

$= 10335{,}63;$

$S19 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (11.735) + (1 - 0{,}5)\ 10335{,}63$

$= 11035{,}31;$

$S20 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (12.192) + (1 - 0{,}5)\ 11035{,}31$

$= 11613{,}66;$

$S21 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (12.296) + (1 - 0{,}5)\ 11613{,}66$

$= 11954{,}83;$

$S22 = \alpha\ Xt + (1 - \alpha)\ S1$

$= (0{,}5)\ (11.253) + (1 - 0{,}5)\ 11954{,}83$

$= 11604{,}91.$

While the graphic display is as follows:

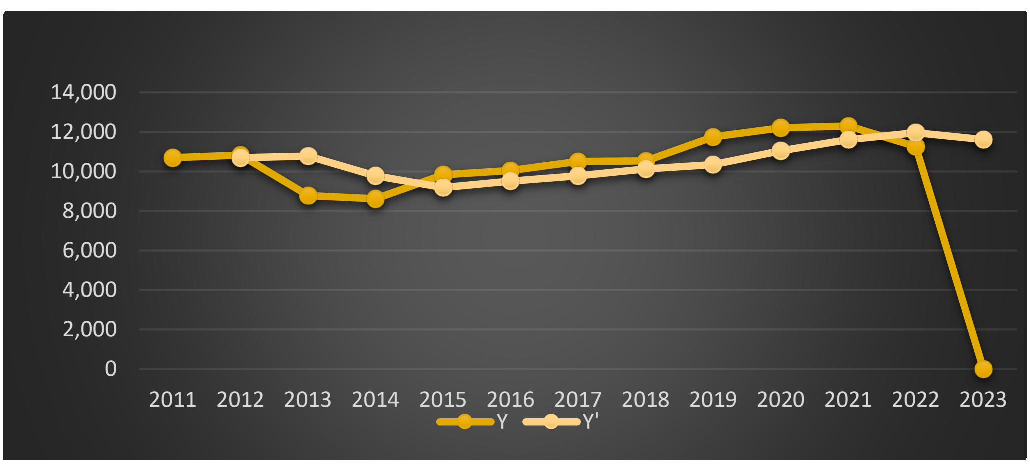

Figure 3. Chart of areca nut plantation production with α = 0.5

The following is the result of the calculation by entering the value of α = 0.7 and the value of 1- α = 0.3:

Table 4. **Forecast Data of Pinang Plantation Production with α = 0.7**

No (X)	Period	And	Y'	MAD	MSE	MAPE
1	2011	10.700	#N/A	#N/A	#N/A	#N/A
2	2012	10.818	10.700	118	13.924	0,010908
3	2013	8.761	10782,6	2021,6	4.086.867	0,23075
4	2014	8.598	9367,48	769,48	592.099	0,089495
5	2015	9.825	8828,844	996,156	992.327	0,10139
6	2016	10.053	9526,153	526,8468	277.568	0,052407
7	2017	10.493	9894,946	598,054	357.669	0,056996
8	2018	10.536	10313,58	222,4162	49.469	0,02111
9	2019	11.735	10469,28	1265,725	1.602.059	0,107859
10	2020	12.192	11355,28	836,7175	700.096	0,068628
11	2021	12.296	11940,98	355,0152	126.036	0,028872
12	2022	11.255	12189,5	934,4954	873.282	0,083029
13	2023	?	11535,35			
Sum						0,851445
						85,14445
						7,095371

c. Forecasting using α = 0.7

$S11$ = 10.700;

$S12 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (10.818) + (1 − 0,) 10.700

= 10782,6;

$S13 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (8.761) + (1 − 0,7) 10782,6

= 9367,48;

$S14 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7)(8.598) + (1 − 0,7) 9367,48

= 8828,844;

$S15 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7)(9.825) + (1 − 0,7) 8828,844

= 9526,153;

$S16 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (10.053) + (1 − 0,7) 9526,153

= 9894,946;

$S17 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (10.493) + (1 − 0,7) 9894,946

= 10313,58;

$S18 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (10.536) + (1 − 0,7) 10313,58

= 10469,28;

$S19 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (11.735) + (1 − 0,7) 10469,28

= 11355,28;

$S20 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (12.192) + (1 − 0,7) 11355,28

= 11940,98;

$S21 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (12.296) + (1 − 0,7) 11940,98

= 12189,5;

$S22 = \alpha\, Xt + (1 - \alpha)\, S1$

= (0,7) (11.253) + (1 − 0,7) 12189,5
= 11535,35.

While the graphic display is as follows:

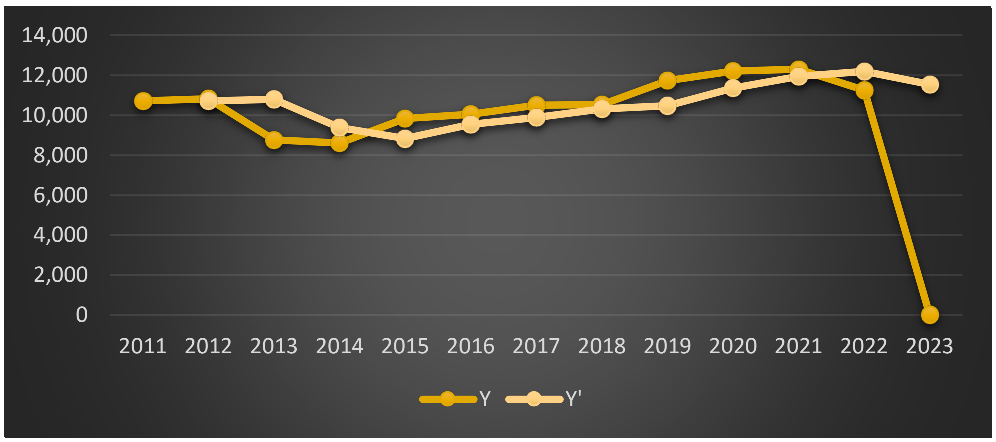

Figure 4. Chart of Pinang Plantation Production with α = 0.7

Forecasting for 2023 using the equation above, so that the forecast of the total data demand for 2023 is as follows:
S' 2023 = (0,3) (11.253) + (1 − 0,3) 11464,94

= 11401,96

S' 2023 = (0,5) (11.253) + (1 − 0,5) 11954,83
= 11604,91

S' 2023 = (0,7) (11.253) + (1 − 0,7) 12189,5

= 11535,35

Based on the results of the permalan that have been obtained from the results of the data analysis above, a comparison of the actual data with the permalan data at each value of α = 0.3 α = 0.5 α = 0.7 is obtained.

3.3 Percentage of Forecast Errors

The percentage of prediction error for Single Exponential Smoothing can be calculated using the formula, so the result is obtained:

Table 5. Forecasting Mistakes Using MAPE

No	Year	Actual Data	Forecast α = 0.3	$\left\lvert\frac{X_t - S'_t}{Xt}\right\rvert$ α = 0,3	Forecast α = 0.5	$\left\lvert\frac{X_t - S'_t}{Xt}\right\rvert$ a = 0,5	Forecast α = 0.7	$\left\lvert\frac{X_t - S'_t}{Xt}\right\rvert$ a = 0,7
1	2011	10.700						
2	2012	10.818	10.700	0,010908	10.700	0,010908	10.700	0,01091
3	2013	8.761	10735,4	-0,22536	10759	-0,22806	10782,6	-0,23075
4	2014	8.598	10143,08	-0,1797	9760	-0,13515	9367,48	-0,0895
5	2015	9.825	9679,556	0,014803	9179	0,065751	8828,844	0,10139
6	2016	10.053	9723,189	0,032807	9502	0,05481	9526,153	0,05241

7	2017	10.493	9822,132	0,063935	9777,5	0,068188	9894,946	0,057
8	2018	10.536	10023,39	0,048653	10135,25	0,038036	10313,58	0,02111
9	2019	11.735	10177,17	0,13275	10335,63	0,119248	10469,28	0,10786
10	2020	12.192	10644,52	0,126926	11035,31	0,094873	11355,28	0,06863
11	2021	12.296	11108,77	0,096555	11613,66	0,055493	11940,98	0,02887
12	2022	11.255	11464,94	-0,01865	11954,83	-0,06218	12189,5	-0,08303
13	2023		11401,96		11604,91		11535,35	
	Sum	127.262	125.624	0,103627	126.357	0,081917	126.904	0,0449

So, the percentage of prediction error of the Single Exponential Smoothing method is as follows:

1). To α = 0.3

$$MAPE = \frac{\sum_{t=1}^{n} \left|\frac{X_t - S'_t}{X_t}\right|}{n} x\ 100\%$$

$$= \frac{0,951054}{12} x\ 100\%$$

$$= 7,92545\ \%\ ;$$

2). To α = 0.5

$$MAPE = \frac{\sum_{t=1}^{n} \left|\frac{X_t - S'_t}{X_t}\right|}{n} x\ 100\%$$

$$= \frac{0,932689}{12} x\ 100\%$$

$$= 7,772412\ \%\ ;$$

3). To α = 0.7

$$MAPE = \frac{\sum_{t=1}^{n} \left|\frac{X_t - S'_t}{X_t}\right|}{n} x\ 100\%$$

$$= \frac{0,851445}{12} x\ 100\%$$

$$= 7,095371\ \%.$$

Based on the MAPE value that has been obtained, it can be seen that at α = 0.7 is the smallest MAPE value. So it can be concluded that the best prediction of areca nut plantations is to use a value α = 0.7.

4. Conclusion

The results of the 2023 forecast are obtained from the total production of areca nut plantations in Riau province using the Single Exponential Smoothing method, namely:

$$S_{t+1} = (0,7)\, X_t + (1 - 0,7)\, S_t$$

This shows an increase in the number of areca nut plantation production in Riau Province from one year earlier, namely in 2022 areca nut plantation production is 11,255, and in 2023 the number of areca nut plantation production is 11,535.35 and the method used to forecast the number of areca nut plantation production in Riau Province in 2023 is in the Single Exponential Smoothing method with a MAPE value of α = 0.7 by 7.095371%.

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