

FORECASTING HARVEST RESULTS OF FRESH FRUIT BUNCHES USING THE SES METHOD

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Abstract: PT. Perkebunan Nusantara IV (Persero) Tinjowan is a state-owned enterprise unit operating in the palm oil plantation industry. In an effort to increase production, the plantation company aims to enhance production efficiency so that palm oil product prices become more competitive by determining harvest yields. The company's harvest yield estimation still uses a traditional approach based on the average bunch weight (BJR), considering the year of planting and the planting area. However, this technique is less effective and efficient. If the company's estimates are incorrect, it can potentially lead to losses or increased production budgets. The purpose of this research is to obtain a comparison of forecast results for the next month with the best alpha accuracy measure using the Single Exponential Smoothing method. The research method used is based on qualitative and quantitative data from interviews and observations of data from December 2022 to November 2023. The forecasting results with an alpha accuracy value of 0.9 using the Single Exponential Smoothing method show a forecast for December 2023 of 13,835.57844 with a percentage error rate (MAPE) of 9.28%, MAD of 1,021,423.6, and MSE of 174,130,366.

Keywords: forecasting; palm oil; single exponential smoothing

Abstrak: PT. Perkebunan Nusantara IV (Persero) Tinjowan sebagai unit usaha BUMN yang beroperasi di industri perkebunan kelapa sawit. Dalam upaya meningkatkan produksi, perusahaan perkebunan, peningkatan efisiensi produksi agar harga produk sawit lebih kompetitif dengan menentukan hasil panen. Pada perkiraan hasil panen perusahaan masih menerapkan pendekatan tradisional berdasarkan berat janjangan rata-rata (BJR) dengan mempertimbangkan tahun tanam dan luas area tanaman. Namun, tehnik ini kurang efektif dan efisien, Apabila perkiraan yang dibuat perusahaan salah berpotensi menyebabkan kerugian atau peningkatan anggaran produksi. Tujuan dari penelitian ini untuk mendapatkan perbandingan hasil peramalan pada bulan berikutnya dengan ukuran akurasi alpha terbaik menggunakan metode Single Exponential Smoothing. Metode yang digunakan dalam penelitian ini adalah berdasarkan data kualitatif dan kuantitatif dari hasil wawancara dan observasi data bulan desember 2022 - november 2023. Hasil peramalan dari ukuran akurasi nilai alpha 0.9 menggunakan metode Single Exponential Smoothing diperoleh peramalan untuk periode desember 2023 sebesar 13.835578,44 dengan tingkat persentase error MAPE sebesar 9,28%, MAD 1021423.6 dan MSE 174130366.

Kata Kunci: kelapa sawit; peramalan; single exponential smoothing

INTRODUCTION

PT. Perkebunan Nusantara IV (Persero) Tinjowan is a State-Owned Enterprise (BUMN) which operates in the plantation industry, cultivating plants, processing and selling palm oil products. In an effort to increase production, plantation companies are also trying to increase production efficiency so that palm product prices are more competitive[1]

PTPN IV Tinjowan still adopts the traditional forecasting concept, to predict future harvest yields by estimating the Average Harvest Weight (BJR) based on the year of planting and the area of oil palm plantations, so this method is less effective and efficient in predicting harvest yields for next period. If the estimate made by the company is incorrect, it will result in a loss and cause the production budget to increase or suffer losses such as the impact on the worker's wage budget, determining the target amount of processed demand, and preparing the overall harvest budget[2].

One aspect of cultivation techniques that has a crucial role in the growth of oil palm is the harvesting process[3]. Harvesting success not only directly influences crop yields, but also has a significant impact on the overall productivity of the oil palm plant. On the other hand, failure to carry out harvesting effectively can be a major obstacle in achieving the desired productivity targets in oil palm cultivation [4]. Therefore, serious attention to harvesting techniques is very important to ensure optimal yields in the palm oil industry [5].

For this reason, in the process of determining the target number of harvests, plantation companies can use a harvest calculation approach or forecast harvest results by applying the *Single*

Exponential Smoothing method [6]. Use of the Single Exponential Smoothing Method will help to determine the ups and downs of the harvest of fresh fruit bunches by averaging (smoothing) past values with series data in a decreasing (exponential) manner[7].

In previous research[8], it was explained that by applying the Single Exponential Smoothing method, it was possible to handle optimal inventory for drug stock inventory control, by using Alpha 0.3 for forecasting experiments for the next 3 months. Forecasting a field of science that is used to predict something using data that existed in the past and processed it in a certain way [9]. The main purpose of forecasting or calculations is to provide a strong basis for determining optimal policies to achieve the desired production targets[10].

This research examines how to apply the Single Exponential Smoothing method in forecasting the yield of Fresh Fruit Bunches (FFB) at PTPN IV Tinjowan. In this way, companies can plan effective strategic steps in managing palm oil harvests efficiently and optimizing business results.

METHOD

The methodology carried out researchers in order to collect information or data and carry out investigations on the data that has been obtained. The research method provides an overview of the research design which includes [11]:

Study of literature

Researchers began looking for reference information in the form of books, journals and study materials

related to the topic of discussing forecasting using the SES method.

Collecting data

The data collection process was carried out in the form of interviews with plantation manager staff regarding oil palm harvest data and observations to observe and analyze the process of harvesting fresh fruit bunches with harvest foremen collected from PTPN IV Tinjowan, which will later be processed using the desktop-based Single Exponential Smoothing method.

System planning

This stage the researcher creates a system design. The aim of system design is to ensure that the designed system is more systematic and effective according to needs, thereby producing a predictive system.

System Implementation

This stage, the aim of implementation is to achieve the goals that have been prepared. In this research, the implementation referred to is implementing all the prediction system designs that have been carried out by researchers.

Single Exponential Smoothing forecasting can be found using the following formula[8]:

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1}) \tag{1}$$

Description,

F_t : forecast for the t-th time period.

F_{t-1} : forecast for the past time period, t-1.

A_{t-1} : actual for one time period ago, t - 1.

α : smoothing constant

To measure the forecasting error value, it can be searched using MSE (Mean Square Error) is an alternative

method in a forecasting method. The smaller the MSE value, the more accurate the prediction [9].

$$MSE = \frac{\sum(Y_t - F_t)^2}{n} \tag{2}$$

Description,

Y_t : Actual value in period t

F_t : Forecast value in period t

n : Number of data for the forecasting period

RESULTS AND DISCUSSION

Data analysis

In the initial step of the analysis, input needs were identified consisting of data on the harvest of Fresh Fruit Bunches (FFB) at PTPN IV PKS Tinjowan Unit for the period December 2022 - November 2023. This data is the basis for carrying out calculations using the Single Exponential Smoothing method.

Table 1. Harvest Data

No	Period	Harvest Yield (Tons)
1	December 2022	11,352,630
2	January 2023	8,370,000
3	February 2023	9,080,000
4	March 2023	9,260,000
5	April 2023	9,870,000
6	May 2023	10,840,000
7	June 2023	13,100,000
8	July 2023	13,520,000
9	August 2023	14,170,000
10	September 2023	14,620,000
11	October 2023	15,010,000
12	November 2023	13,710,000

Source: PTPN IV PKS Tinjowan Unit, 2023

The input data will be processed using the Single Exponential Smoothing method with an alpha value of 0.1 to 0.9 to calculate data using manual methods and system calculation methods.

Process Analysis

The data calculation process stage uses the Single Exponential Smoothing method, which will be later get the results of forecasting Fresh Fruit Bunches (FFB) in the following month's period by applying equation (1), if an error occurs in the forecast value then the Mean Squared Error method is used for each alpha value with equation (2).

in this discussion, Calculation of Fresh Fruit Bunch (FFB) Single

Exponential Smoothing Method Using Alpha 0.9, which is the best value. From the results of calculating predictions for the harvest of fresh fruit bunches (FFB) of PTPN IV Tinjowan PKS Unit using an alpha value of 0.9, the smallest MAPE error rate results were obtained at 9.28%, namely 13,835,578 tons to predict the next month's harvest in the Very Forecasting Ability category. OK, it can be seen in table 2.

The Alpha Forecasting Error Value of 0.9 can be seen in table 3. Meanwhile, to see the Alpha Forecasting Value Results of 0.1 to 0.9, it is attached in table 4.

Table 2. Calculation of Fresh Fruit Bunch (FFB) Single Exponential Smoothing Method With Alpha 0.9

Period	Yt	Alpha	AlphaYt	1-Alpha	Ft
1	11,352,630				
2	8,370,000	0.9	7,533,000.00	0.1	11,352,630.00
3	9,080,000	0.9	8,172,000.00	0.1	8,668,263.00
4	9,260,000	0.9	8,334,000.00	0.1	9,038,826.30
5	9,870,000	0.9	8,883,000.00	0.1	9,237,882.63
6	10,840,000	0.9	9,756,000.00	0.1	9,806,788.26
7	13,100,000	0.9	11,790,000.00	0.1	10,736,678.83
8	13,520,000	0.9	12,168,000.00	0.1	12,863,667.88
9	14,170,000	0.9	12,753,000.00	0.1	13,454,366.79
10	14,620,000	0.9	13,158,000.00	0.1	14,098,436.68
11	15,010,000	0.9	13,509,000.00	0.1	14,567,843.67
12	13,710,000	0.9	12,339,000.00	0.1	14,965,784.37
13	14,965,784.37	0.9	13,469,205.93	0.1	13,835,578.44

Table 3. Alpha Forecasting Error Value 0.9

Ft-Yt	Ft- Yt	(Ft- Yt)^2	Ft- Yt /Yt
2,982,630.00	2,982,630.00	8,896,081,716,900.00	0.36
- 411,737.00	411,737.00	169,527,357,169.00	0.05
- 221,173.70	221,173.70	48,917,805,571.69	0.02
- 632,117.37	632,117.37	399,572,369,455.72	0.06
- 1,033,211.74	1,033,211.74	1,067,526,493,474.56	0.10
- 2,363,321.17	2,363,321.17	5,585,286,970,058.75	0.18
- 656,332.12	656,332.12	430,771,848,291.39	0.05
- 715,633.21	715,633.21	512,130,893,741.01	0.05
- 521,563.32	521,563.32	272,028,297,993.74	0.04
- 442,156.33	442,156.33	195,502,222,031.49	0.03
1,255,784.37	1,255,784.37	1,576,994,375,869.80	0.09
- 2,758,831.60	11,235,660.33	19,154,340,350,557.10	1.02

Table 4. Results of Alpha Forecasting Values 0.1 to 0.9

Alpha	Forecasting	MAD	MSE	MAPE
0.1	12,252,673.07	2160250.89	5584740662287.40	18.17%
0.2	13,123,735.30	1921106.73	4632181548181.11	16.21%
0.3	13,698,616.85	1646352.32	3756073594876.03	14.05%
0.4	13,997,372.60	1511788.62	3088575446285.11	13.02%
0.5	14,107,638.00	1368161.18	2605658634041.04	11.88%
0.6	14,106,616.69	1230078.80	2260714462938.70	10.76%
0.7	14,044,562.25	1128260.95	2017039367927.34	9.97%
0.8	13,949,466.88	1055088.63	1849512388033.02	9.43%
0.9	13,835,578.44	1021423.67	1741303668232.47	9.28%

The results of the design of the system built in predicting the yield of Fresh Fruit Bunches (FFB) at PTPN IV PKS Tinjowan Unit can be seen in Figure 1.



Image 1. Admin Main Menu Page

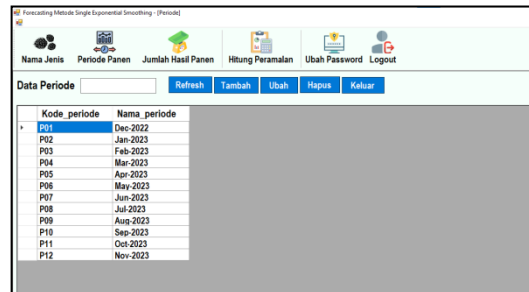


Image 2. Harvest Period Menu Page

Image 2 is the display of the harvest period menu page which displays harvest period data that has been input

by the admin into the system and is used by the admin to add, change and delete harvest period data to the system.

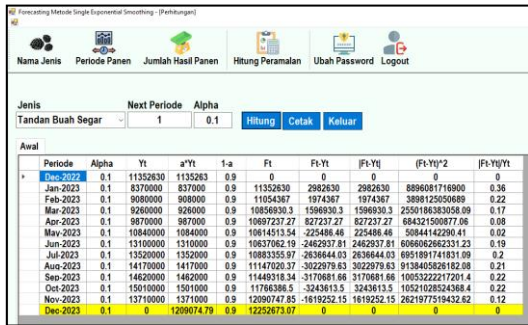


Image 3. Display the Forecast Calculation Form

The image 3 is a display of the forecasting calculation form that will appear after the user selects the forecasting period and alpha. The forecasting calculation form is equipped with a print button. Based on these buttons, users can view and print forecasting results.

The last image is the print page display that appears when all users click the print button. The data contained on the printed page is data from the calculation of single exponential smoothing for the December 2023 period, which is 13,835,578.44 with a MAPE error percentage rate of 9.28%, MAD 1021423.6 and MSE 174130366.

PTPN IV PKS Unit Tinjowan

Huta Parik, Ujung Padang, Kabupaten Simalungun, Sumatera Utara

HASIL PERHITUNGAN

Periode	Data Aktual	Hasil Forecast	Ft-Yt	Ft-Yt	Ft-Yt ^2	Ft-Yt /Yt
Dec-2022	11,352,630		0.00	0.00	0.00	0.00
Jan-2023	8,370,000	11352630.00	2,982,630.00	2,982,630.00	8,896,081,716,900.00	0.36
Feb-2023	9,080,000	8668263.00	-411,737.00	411,737.00	169,527,357,169.00	0.05
Mar-2023	9,260,000	9038826.30	-221,173.70	221,173.70	48,917,805,571.69	0.02
Apr-2023	9,870,000	9237882.63	-632,117.37	632,117.37	399,572,369,455.72	0.06
May-2023	10,840,000	9806788.26	-1,033,211.74	1,033,211.74	1,067,526,493,474.56	0.10
Jun-2023	13,100,000	10736678.83	-2,363,321.17	2,363,321.17	5,585,286,970,058.75	0.18
Jul-2023	13,520,000	12863667.88	-656,332.12	656,332.12	430,771,848,291.39	0.05
Aug-2023	14,170,000	13454366.79	-715,633.21	715,633.21	512,130,893,741.01	0.05
Sep-2023	14,620,000	14098436.68	-521,563.32	521,563.32	272,028,297,993.74	0.04
Oct-2023	15,010,000	14567843.67	-442,156.33	442,156.33	195,502,222,031.49	0.03
Nov-2023	13,710,000	14965784.37	1,255,784.37	1,255,784.37	1,576,994,375,869.80	0.09
Dec-2023		13835578.44	0.00	0.00	0.00	0.00

MAD 1021423.6

MAPE 9.28%

MSE 174130366

Jadi, untuk peramalan periode Dec-2023 adalah 13835578.44 dengan persentase kesalahan 9.28%

Ujung Padang, 01 February 2024

Manajer PKS

A. REZAK

Image 5. Print page display of forecasting results using the system

CONCLUSION

The design and testing of the system built using the Single Exponential Smoothing method in the research carried out was able to provide forecasts for the results of Fresh Fruit Bunches (FFB) at PTPN IV PKS Tinjowan Unit in the following period. By testing the use of different Alpha values, the prediction results for the Very Good forecasting ability category were found using Alpha 0.9. The application of the Single Exponential Smoothing algorithm can make it easier for the PTPN IV PKS Tinjowan company in making decisions to achieve the desired crop production targets.

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