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FORECASTING MODEL OF ONIONS IN SUMBAWA DISTRICT

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ABSTRACT

Sumbawa Regency, as the second largest shallot-producing area in NTB, certainly contributes to food security in Sumbawa Regency in particular and in Indonesia in general. This condition certainly needs to make policymakers predict crop yield growth for the following years. This study aims to predict shallot yields for the next nine years. The data used is secondary data sourced from the Sumbawa District Agriculture Office. There are three trend forecasting methods used, namely the least square method, quadratic and exponential trend models. Based on the calculation results, the best forecasting trend model is obtained, namely the exponential trend model with MAPE and MAD values and the largest coefficient of determination (R^2). The exponential trend obtained shows a positive trend, namely positive exponential values and positive principal numbers.

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1. INTRODUCTION

The agricultural sector is a sector that provides the main food needs, especially in developing countries [1]. As an agrarian country, Indonesia still relies on agriculture as the main source of its economy, especially in rural areas [2]. An advanced agricultural sector with optimal results certainly supports the level of welfare of its population. Production results each year, of course, create their trend. Trends for preparedness for the following years require precise and accurate predictions or forecasts that are measurable according to scientific concepts. Forecasting the results of agricultural production is very necessary for countries where most of the population depends on agricultural products [3]. With this description, the government can take anticipatory steps to overcome problems that will arise [4]. To realize this, development must be carried out in stages in all fields and sectors, and sub-sectors in a planned and programmed manner [5]. Forecasting is the initial part of the decision-making process [6].

Sumbawa Regency is one of the regencies in West Nusa Tenggara as the second highest shallot producer after Bima Regency (BPS NTB). The favorable climate and weather certainly provide distinct advantages for Sumbawa Regency, making it the main barn for shallots in West Nusa Tenggara. The production area spread until 2021 will continue to increase along with the trend of shallot yields which tend to increase every year. Predictions are made using data from several previous years, with the involvement of the time parameter in the prediction process benefiting the company in making effective and efficient planning [7]. The purpose of forecasting in production activities is to reduce uncertainty so that an estimate close to the actual situation is obtained [8]. Forecasts are always made in order to minimize the effect of this uncertainty on a problem [9].

There are many forecasting methods and trends that are quite good at predicting future conditions. Three types of methods are used in this study, namely the trend model of the least square linear, quadratic, and exponential methods. These three methods are used to compare the trend of which model is the best to be used to forecast shallot yields in the following years. The three trend models will be compared, and the best trend will be used.

There are several previous studies that became the reference of this research. One was carried out by Wahyu Fuadi et al. (2021) [9] about forecasting rice yields using the double exponential smoothing method in Meurah Mulia District. This study uses the double exponential smoothing method with initial data from the last 4 years. Apart from that, another research that became the reference for this research was conducted by Madu (2016) [10], which compares forecasting with the trend projection method and the backpropagation method. The data used is three years data. After forecasting the trend projection, the best trend is obtained, namely the quadratic trend model. However, compared with the backpropagation method, the best is forecasting backpropagation. In this research, the data used to predict is more, namely data for the last 18 years, so that the trends that occur will be better, which will later affect the trend forecasting model used. In addition, this study compares three types of trend forecasting models, namely the least square linear method, quadratic and exponential method, so that there are more and more comparisons which are of course very good for determining which forecasting model is best used for this study. In addition, this study uses the 4 parameters to calculate the best trend models, namely MAPE, MAD, MSD, and R^2.

Shallots provide significant income for the economic cycle in Sumbawa Regency. This is not only felt by farmers but also by landowners who are usually leased to farmers, 90% of whom are farmers from the Mbojo tribe. Therefore, forecasting shallot yields for the coming years is very necessary for policy-making as well as patterns of distribution of supporting elements such as circulation of fertilizers, agricultural medicines, and maps of the distribution of planting areas.

2. RESEARCH METHODS

The data used in this study is secondary data on the total yield of shallots in Sumbawa Regency, which is sourced from the Agriculture Office of Sumbawa Regency. The data used is for the last 18 years, from 2004 to 2021. The forecasting method uses three trend methods, namely the least square method, quadratic method, and exponential method, which will later be compared which is the best trend of the three methods. Trend describes the movement of time series data over a long or long period of time and tends towards one direction (up or down) [11]. The Least Square method is used to determine the trend equation of data, which includes Time Series analysis with two cases, namely the case of even and odd data [12]. A quadratic trend

is a trend in which the value of the dependent variable increases or decreases not linearly or occurs as a parabola when the data is made into a scatter diagram [13]. There are many methods that can be used to make forecasting, and to choose the right method. A calculation is needed to assess the accuracy of forecast errors [14]. The best forecasting trend model accuracy uses three methods, namely MAPE (Mean Absolute Percentage Error), MAD (Mean Absolute Deviation), and MSD (Mean Squared Deviation). In addition, to choose the best trend forecasting model also by comparing the value of the coefficient of determination (R^2) between the three trend forecasting models used.

3. RESULTS AND DISCUSSION

The data for this study used data on shallot harvests in Sumbawa Regency for 18 years from 2004-2021. This data is annual data. The red bottom yield data is shown in Table 1 below:

Table 1. Yields of Shallots in Sumbawa Regency

Year	Productivity (Ton)
2004	4960
2005	3017
2006	2135
2007	10359
2008	17698
2009	104593
2010	8778
2011	6481
2012	11975
2013	11904
2014	17642
2015	23935
2016	31951
2017	33950
2018	28678.2
2019	20492.17
2020	23713.29
2021	26183.25

***Data source**: Sumbawa District Agriculture Service*

There are three methods of trend forecasting models used. The three methods will be compared, which one is the best which will be used to predict shallot production for the next 10 years. The trend forecasting model is:

1. Trend Least Square Linier Method

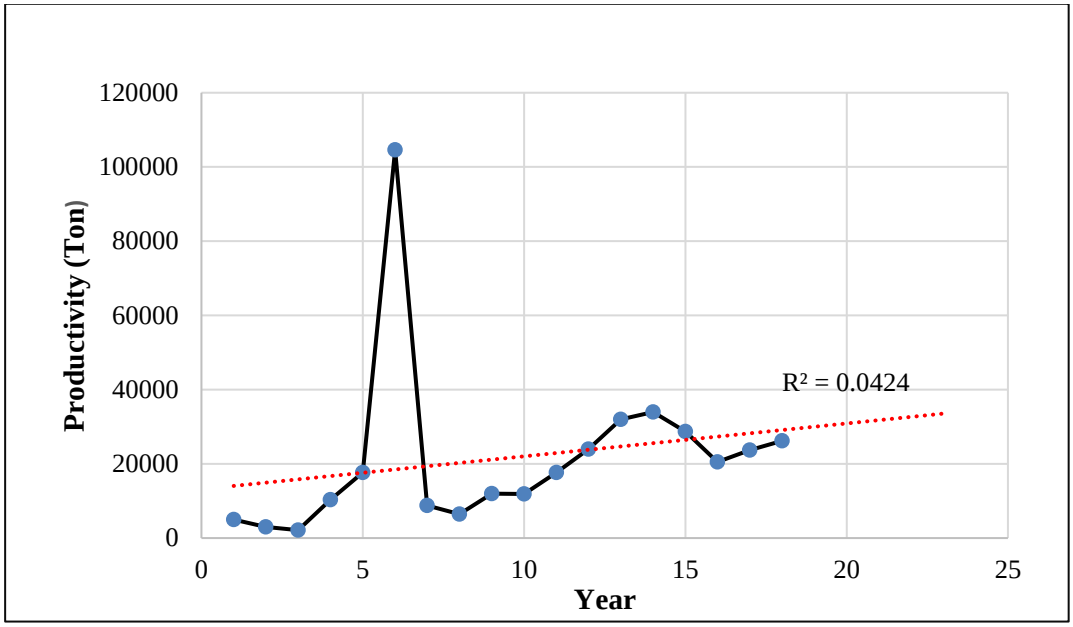

Figure 1. Linear Trend Model

By using a linear trend, the equation **y = 885,83x + 13165** is obtained with a coefficient of determination R^2 of 0.0424. Based on the graphic image in the **Figure 1** and the trend equation, it can be seen that the trend model for forecasting the shallot yields of the Mbojo tribe is positive, meaning that there is an increase every year.

2. Trend Quadratic Model

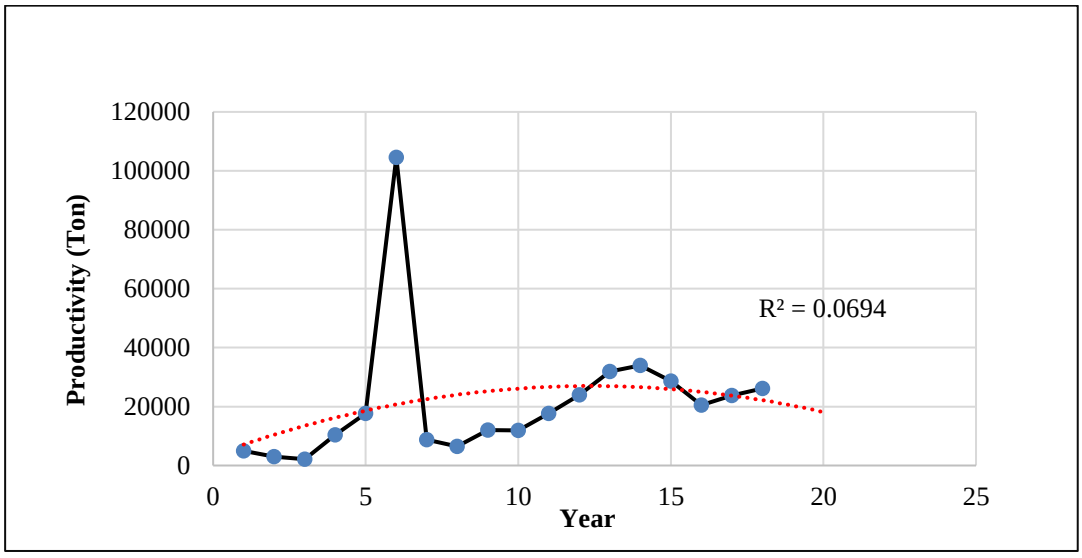

Figure 2. Quadratic Trend Model

By using the quadratic trend model, the equation is obtained **$y = -153.04x^2 + 3793.6x + 3472.2$** with a coefficient of determination (R^2) of 0.0694. It can be seen in **Figure 2** that there are several trend lines that are close to the actual values, such as in periods 15, 16 and 17.

3. Trend Exponential Model

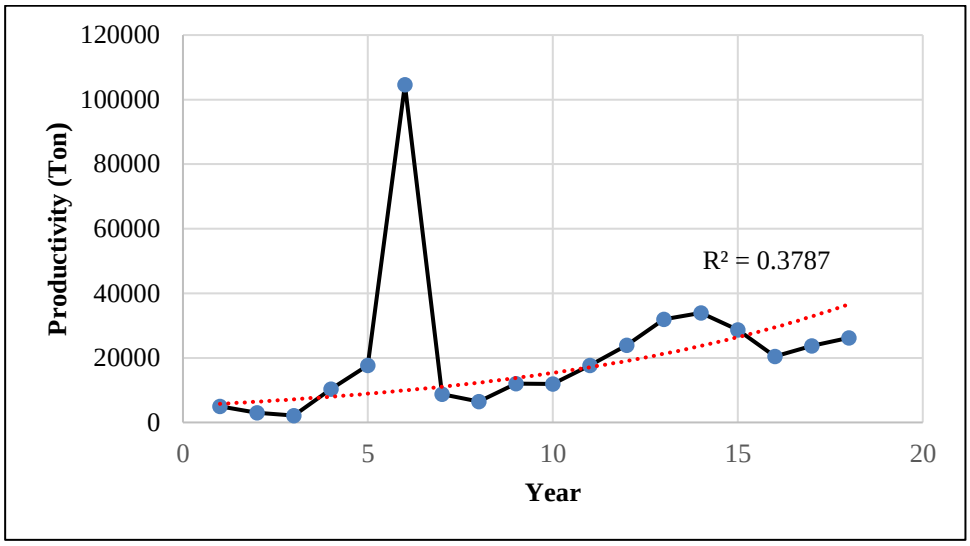

Figure 3. Exponential Trend Model

Using the exponential trend model as shown in **Figure 3**, the equation is obtained $\mathbf{y = 5169.7e^{0.1088x}}$ with the value of the coefficient of determination (R^2), it can be seen in the figure that several trend points are close to actual points, such as in periods 2, 3, 7, 9, 10, 11, 12 and 15. More than in the other two trend models.

a. Best Trend Model Analysis

A forecasting error test compares forecasting results with actual data **[15]**. The smaller the error value, the higher the accuracy of the forecast, and vice versa **[3]**. The coefficient of determination (R^2) essentially measures how far the model's ability to explain the variation of the dependent variable and states a measure of the accuracy or suitability of a regression line applied to a group of research data and is used to determine the proportion of the total diversity of response variables explained by several explanatory variables separately together **[11]**.

Table 2. Calculation Result MAPE, MAD, MSD, and R^2

Trend Model	MAPE	MAD	MSD	R^2
Least Square Linear	0.98224621	11444.92389	463637409.7	0.0424
Quadratic	1.115306	11581.91778	477086919.2	0.0694
Exponential	0.855441288	10311.2811	536548095.7	0.3787

Based on MAPE, MAD, and MSD values in **Table 2**, the smallest value is obtained for MAPE and MAD, namely the exponential trend model. Meanwhile, the smallest MSD is a linear trend model. The largest value of R^2. MAPE is usually more meaningful than MAD and MSD because MAPE states the percentage of forecasting results against actual demand during a certain period which will provide information on the percentage of errors that are too high or too low **[16]**.

b. Forecasting With the Best Trend Model

After comparing the measure of accuracy and the coefficient of determination (R^2) so that the best trend model is obtained, namely the exponential trend model, the results of forecasting the amount of shallot yields for 2022 – 2030 are presented in **Table 3**:

Table 3. Forecasting Shallot Yields with The Exponential Trend Model

Year	Forecast (Ton)
2022	40854.40544

Year	Forecast (Ton)
2023	45550.18384
2024	50785.69192
2025	56622.96584
2026	63131.17217
2027	70387.42745
2028	78477.71191
2029	87497.88834
2030	97554.83789

Based on the forecasting value in **Table 3** it appears that the trend of shallot yields for the farmers of the Mbojo tribe in Sumbawa Regency is positive, meaning it increases every year.

Of the three trend forecasting models used, the best trend forecasting model is obtained, namely the exponential model with the smallest MAPE and MAD values. In addition, the determination of the exponential model as the best trend model is based on the largest coefficient of determination (R2) of the other three methods. If you pay attention to the three trend models used, the pattern and trend of shallot yields in Sumbawa Regency tendJeklin to be positive, meaning that it has increased every year. This can be seen from the coefficient value of the variable x in the trend least square method model. Another thing that shows the trend model of shallot yields is the exponential value of the exponential model, which is positive. This results in the forecasting value of shallot yields going up every year. The average increase in shallot yields is 6.3333 tons from 2023 to 2030. This increase is, of course, directly proportional to the area of planted land, which tends to increase every year.

4. CONCLUSIONS

Based on the results of forecasting with three methods by looking at the smallest value of the measure of accuracy and the largest value of the coefficient of determination (R^2), the best method is obtained that can be used for forecasting onion yields in Sumbawa Regency, namely the exponential trend model with the equation $\mathbf{y = 5169.7e^{0.1088x}}$.

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