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FORECASTING ANALYSIS OF SHALLOTS (*Allium* cepa *L.*) IN NORTH SUMATRA PROVINCE

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Abstract

This study aims to analyze the results of *the trend of* shallot production in North Sumatra in 2021-2030 whether it will increase or not. The data used in this research is secondary data. The object of research in this study is statistical data on the annual shallot production in North Sumatra Province at the Central Bureau of Statistics (BPS) for 2011-2020. The appropriate research method in this study uses *the trend* parabola. This is because *the trend parabola has the smallest Mean Squared Error* (MSE) value of 4,215,734.62 and the smallest percentage of *Mean Absolute Percentage Error* (MAPE) is 2.1% compared to other methods. The results showed that *forecasting* shallot production in North Sumatra Province has increased. There is a deficit between shallot consumption and production, for this reason it is necessary to breed shallot seeds, and increase the area of shallot plantations in North Sumatra Province to increase shallot production and productivity to be able to meet the demand for shallot consumption in North Sumatra Province.

Keywords: *Forecasting; Shallot; Production; MSE*

INTRODUCTION

Agriculture is an important sector that is of concern to the government besides the industrial sector. The priority is more aimed at the development of horticultural crops which the government has so far imported to meet domestic needs. One of the horticultural commodities that cannot be separated from the discussion is shallots.

Shallots (Allium *cepa* L.) according to its early history, this plant has a close relationship with onions, which is a form of plant resulting from natural selection of variants in the onion population. In Indonesia, shallots are grown and cultivated by farmers, starting from the lowlands to the highlands. The cultivation system is a development of traditional ways subsistence to intensive and market-oriented cultivation methods. So far, shallot production has not been optimal and is still reflected in the diversity of cultivation methods which are characterized by specific agro-ecosystems where shallots are cultivated (Sartono Putrasamedja and Suwandi, 1996).

The demand for shallots will continue to increase in line with the increasing needs of the community due to an increase in population, the growing industry for processed products made from shallots (fried shallots, cooking spices) and market development. The increasing need for shallots is a potential market opportunity and can be a motivation for farmers to increase shallot production (Taufiq, 2021).

The Food Crops and Horticulture Office of North Sumatra Province recorded that the harvest volume of shallots in North Sumatra throughout 2020 was 26,000 tons. This amount is only able to meet 60% of the needs for shallots in North Sumatra Province. (Food Security Agency, 2021). The amount of red onion needs in North Sumatra Province can be seen in the following table:

Table 1. Total Demand for Shallots in North Sumatra Province

Year	Demands (Tons)

Year	Demands (Tons)
2014	35,598
2015	34,647
2016	41,991
2017	37,996
2018	40,795

Source: Central Bureau of Statistics for North Sumatra Province (2018)

From the table 1 above it can be seen that the highest demand for shallots in the past 5 years was in 2016 and 2018, namely 41,991 tons and 40,795 tons, and is likely to continue to increase in the following years. This is due to the increasing population so that the need for shallots in North Sumatra Province also increases. However, when viewed from the amount of shallot production in North Sumatra Province, currently it is only able to meet around 50-60 percent of shallot needs in North Sumatra Province. In this case there is a significant comparison between the amount of shallot production and consumption. For this reason, it is necessary to have a *forecasting* analysis or forecasting regarding how the North Sumatra Provincial Government will meet and anticipate the needs for shallots in the next 10 years.

Forecasting *is* an activity to find out what will happen in the future using and considering data from the past. Absolute accuracy in predicting an event is impossible to achieve. Therefore, when they cannot see future events with certainty, it takes a lot of time and money so that they can have the strength to face the future. come (Fadhil, 2021).

According to Maryati (2010; 129) states *trend* is a movement (tendency) up or down in the long term, which is obtained from the average change over time. The average change can increase or decrease. If the average change increases, it is called a positive *trend* or *the trend* has an upward trend. Conversely, if the average change decreases, it is called a negative *trend* or *a trend* that has a downward trend.

Judging from the problems above, the researcher is interested in raising research with *the* title " *Forecasting* Analysis of Shallot Production (*Allium cepa* L.) in North Sumatra Province". This research was conducted to see forecasts regarding shallot production in the next 10 years to become a reference in making decisions and to anticipate actions to be taken in the future.

RESEARCH METHODS

Research Location and time

This research was conducted in North Sumatra Province. The study was conducted for approximately 3 months, starting from July – September 2022.

Data Types and Sources

The data collected in this study were in the form of secondary data obtained from the Food Crops and Horticulture Office of North Sumatra Province and the Central Bureau of Statistics of North Sumatra Province.

Data Analysis

To complete the forecasting analysis, one of the three *forecasting analysis methods is used* through *the trend* which will be determined by testing the MSE value and the MAPE value. The three *forecasting* analysis methods include the following:

The first method is *trend linear*. The *linear trend* line equation according to Wooldridge (2009) can be formed as follows:

$Yt = a + bt + e_t, t = 1, 2, ...$

The value of b will be obtained from:

$\Delta Y_t = Yt - Y_{t-1} = b, \Delta e_t = 0$

Where:

Y_t = shallot production in year t
Y_{t-1} = shallot production in year t-1
t = Time (year is denoted in numbers)
a = Coefficient *of intercept*
b = Regression coefficient of t
e_t = Other influencing factors (et = 0)

The second method is *the trend* parabola. The parabolic *trend* line equation according to Wooldridge (2009) is as follows:

$Y_t = a + bt + ct^2 + e_t$

Where:

Y_t = shallot production in year t
T = Time of year denoted by numbers)
t^2 = Time squared (year is denoted by a number)
a = Coefficient *of intercept*
b = Regression coefficient of t
c = Regression coefficient of t^2
e_t = Other influencing factors (et = 0)

The third method is the exponential *trend*. The exponential *trend* equation according to Wooldridge (2009) is as follows:

$Log(Y_t) = a + b_t + e_t, t = 1,2,...$

To get the value of b in the following way:

$Log(Y_t) = (Y_t - Y_{t-1})/Y_{t-1}, \Delta e_t = 0$

$\Delta \log(Y_t) = b$

Where:

Y_n = shallot production in year t
Y_{t-1} = shallot production in year t-1
a = Coefficient *of intercept*
b = Regression coefficient of t
t = Time (year is denoted by a number)
e_t = other influencing factors ($_{et}$ = 0)

After the results are obtained, they are then converted back to the exponential equation with an antilog. Then the exponential *trend line can be predicted* in the future with the following equation:

$\hat{Y} = ab^t$

Where:

$\hat{Y}$ = Predicted shallot production
a = Coefficient *of intercept*
b = The average increase in Y per unit time
t = Predicted time (year is denoted by a number)

Among the three methods above, one of them will be chosen as the best method for predicting shallot production based on its MSE and MAPE values. According to Pakaja, et al (2012), *Mean Squared Error* (MSE) is another method for evaluating forecasting methods. Each error or remainder is squared. This approach allows for large forecasting errors because the errors are squared. The method yields moderate errors which may be better for small errors, but sometimes makes a big difference. MSE is the average of the squared difference between the predicted and observed values. According to Shcherbakov, et al (2013) the MSE formula is as follows:

$MSE = (\frac{1}{n}\sum_{i=1}^{n} e_i)^2 = mean_{\text{i-1.n}} (e_i^2)$

To get the value of e in the following way:

$e_i = (y_i - \int_i^{(n)})$

Where:

n = Number of data
e = Errors
i = Year
y = Value measured at time i
f = The predicted value at time i

The method with the lowest MSE value is the best method to be used to predict shallot production in the future. According to Pakaja, et al (2012), *Mean Absolute Precentage Error* (MAPE) is a measurement of error that calculates the size of the percentage deviation between actual data and forecasting data. MAPE is calculated by dividing the absolute error for each period by the real observed value for that period, then averaging the absolute percentage errors.

According to Shcherbakov, et al (2013) the MAPE formula is as follows:

$\text{MAPE} = \frac{1}{n}\sum_{i=1}^{n} 100.|p_i|$

To get the value of p_i in the following way:

$|p_i| = \frac{|ei|}{Yi}$

Where:

N = Number of data
$|e_i|$ = absolute error value at time i
I = Year
Y_i = The value measured at time i
$|p_i|$ = absolute error value per value measured at time i

According to Amalia (2016), MAPE has several criteria in forecasting, namely very accurate forecasting if MAPE <10%, accurate forecasting if MAPE is 10-20%, accurate forecasting if MAPE is 20-50 %, and less accurate if MAPE is > 50%.

RESULTS AND DISCUSSION

Linear *trends*

Based on the processing results of shallot production data for North Sumatra Province in 2011-2020 using the assistance of Ms. Excel obtained the linear *trend equation* for shallot production in North Sumatra Province as follows:

$$\hat{Y} = 14.5793 + 747.894t$$

Judging from the linear *trend equation* above, the projected value of shallot production for North Sumatra Province for 2011-2020 will be obtained by replacing the t (time) value in the equation with a predetermined number notation for each year.

Parabolic *trend*

Based on the processing results of shallot production data for North Sumatra Province in 2011-2020 using Ms. Excel obtained the *trend equation* of the shallot production parabola of North Sumatra Province as follows:

$$\hat{Y} = 10.68102 + 747.894t + 118.13t^2$$

trend equation above, the projected value of shallot production for North Sumatra Province for 2011-2020 will be obtained by replacing the t (time) value in the equation with a predetermined number notation for each year.

Exponential *Trends*

Based on the processing results of shallot production data for North Sumatra Province in 2011-2020 using Ms. Excel obtained the exponential *trend equation* for shallot production in North Sumatra Province as follows:

$$\hat{Y} = 13.56959\ (1.047252)^{t}$$

From the exponential *trend equation* above, the projected value of shallot production for North Sumatra Province for 2011-2020 will be obtained by replacing the t (time) value in the equation with a predetermined number notation for each year. *trend* methods above, it will then be tested again using MSE *(Mean Square Error)* and MAPE *(Mean Absolute Precentage Error)* and the following results will be obtained:

Table 2. MSE and MAPE Test Results for the *Trend* Forecasting Method of Shallot Production in North Sumatra Province

Analysis Method	Mathematical Forms	MSE	MAPE (%)
linear	Y = a + bt	16,018,858.92	7
Parabola	$Y = a + bt+ct^2$	4,215,734.62	2.1
Exponential	$Y = ab^t$	13,905,740.61	6,8

Source: primary sources, 2022

Based on table 4.4, it can be concluded that the parabolic *trend method* is the most suitable method for forecasting shallot production in North Sumatra Province. This is because *the trend* parabola has the smallest MSE value of 4,215,734.62 and the smallest MAPE percentage of 2.1% compared to other methods.

***Forecasting* Analysis of Shallot Production in North Sumatra Province for 2021-2030**

By using the parabolic *trend equation* that has been obtained, the forecasting results for shallot production in 2021-2030 are as follows:

Table 3. Forecasting of Shallot Production in 2021-2030

Year	Shallot Production (Tons)
2021	33,202
2022	36,666
2023	40,368
2024	44,305
2025	48,479
2026	52,889
2027	57,535
2028	62,417
2029	67,536
2030	72,891

Source: Primary sources, 2022

Based on table 3, the results of forecasting shallot production for North Sumatra Province in 2021-2030 using a parabola *trend* have increased every year. Forecasting conditions for shallots in North Sumatra Province for 2021-2030 can be seen in Figure 1.

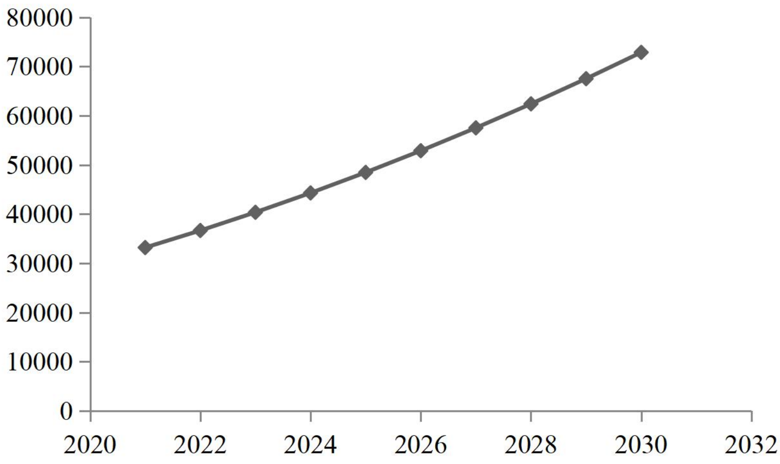

Figure 1 Graph Forecasting Shallot Production for 2021-2030

Based on Figure 1, the results of forecasting shallot production in North Sumatra Province for 2021-2030 using *a trend* parabola show an increase every year. So that the forecast for shallot production in North Sumatra Province for 2021-2030 using the parabolic *trend method* has increased or experienced a positive**.** The increase in shallot production in North Sumatra Province is most likely caused by several factors, including: Land area, consumption, and several shallot development policies.

CONCLUSIONS AND SUGGESTIONS

The MSE and MAPE test results show that the *trend* parabolic method is the most suitable method for predicting shallot production with MSE and MAPE values of 4,215,734.62 and 2.1% for shallot production in North Sumatra Province. The results of the *forecasting* analysis show that forecasting shallot production in North Sumatra Province for 2021-2030 is experiencing a positive/increasing *trend.* The increase in shallot production was caused by several factors, including land area, consumption, and development efforts from the government.

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