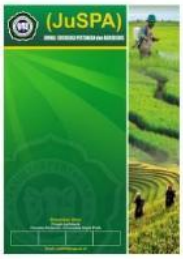

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ANALYSIS OF FORECASTING OF FARMER EXCHANGE RATE FOR THE FOOD CROP SUBSECTOR IN NORTH SUMATRA PROVINCE USING ARIMA METHOD

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Abstract. One of the measurements the level of farmer welfare is by calculating the Farmer Exchange Rate (NTP). This study aims to analysis of forecasting and describe the results of forecasting the farmer exchange rate (NTP) for the food crop subsector in 2025-2027 using the ARIMA method. This research employs descriptive and econometric analysis using time series NTP for the food crop subsector from January 2020 to December 2024 in North Sumatra Province, obtained from the BPS SUMUT website. This study shows that the best forecasting model is ARIMA (2,1,0) and the forecasting results show an increasing trend, but the NTP value < 100 percent, so food crop farmers in North Sumatra are not yet wealthy.

Keywords: Forecasting; Subsector Farmer Exchange Rate Food Crop; Agriculture; ARIMA method; North Sumatra Province

1. Introduction

The agricultural sector is one of the sectors that contributes to improving the national economy in terms of economic growth, job creation, food supply for consumption, and raw materials for industry in Indonesia. The agricultural sector is a major focus of the government, particularly the food crop subsector, because food crops are the most important crops consumed by humans, consisting of rice and secondary crops. The demand for food crops will continue to rise in line with population growth. It is no surprise that the food crop sub-sector in Indonesia is projected to contribute 2.19 percent of Indonesia's total GDP in 2024 (BPS, 2024).

In 2024, North Sumatra ranked sixth in Indonesia for rice production, with 2.2 million tons, and third for corn production, with 1.3 million tons (BPS, 2024). Furthermore, there are several other food crops such as green beans, soybeans, peanuts, cassava, sweet potatoes, and taro that are still cultivated, but their production remains relatively low compared to other provinces in Indonesia. The growth of the agricultural sector in the subsector of food is not only in terms of availability but also sustainability. Sustainability means maintaining food security in the future, but it must also increase farmers' incomes so that their daily needs can be fulfilled. The primary priority in developing the agricultural sector is the welfare of farmers and their families, particularly in regions with a prominent agricultural sector, which can improve regional income, especially for rural residents still living below the poverty line (Anggriawan and Toti Indrawati, 2013).

The development of agriculture is oriented to improving the welfare of farmers by calculating the Farmer Exchange Rate (NTP). The NTP is the relationship between the products sold by farmers and the goods and services purchased by farmers (Rachmat,

2013). There are two components required in calculating the Farmer Exchange Rate for the Food Crops subsector, namely the price index received by farmers and the price index paid by farmers. The components that make up the price index received by farmers come from the rice/paddy and secondary crops groups, which consist of milled dry paddy (GKG), harvested dry paddy (GKP), milled dry glutinous paddy, harvested dry glutinous paddy, corn, green beans, soybeans, peanuts, cassava, sweet potatoes, and taro.

The upward and downward movements of the farmer's exchange rate (NTP) reflect the fluctuations in farmers' welfare levels. Thus, farmers are relatively more welfare when the NTP is higher, as this also increases the purchasing power of farmers' income relative to their consumption needs (Nurasa, 2016). According to Suhariyanto (2021), the level of farmers' welfare does not experience significant increases each year due to inflation. In addition, farm labor wages only experience very small increases each year. However, increases in production do not correlate directly with increases in the Farmer Exchange Rate (NTP).

In 2024, the farmer exchange rate (NTP) for the food crop subsector in North Sumatra was 100.09 percent (NTP Database, 2024). This means that an NTP equal to 100 is a situation where increases or decreases in product prices correspond to the percentage decrease or increase in the prices of farmers' consumption goods. This means that food farmers in North Sumatra are at a break-even point or have not experienced any changes, so the current level of welfare for food farmers in North Sumatra remains unchanged (BPS, 2024). The availability of this data is crucial as one of the indicators of the success of government development efforts. To ensure accurate and timely results, support from various parties, particularly the government and the public as data sources, is required. Given the importance of the NTP, forecasting its value for the following year would be very beneficial.

This study is supported by previous research conducted by Sorlury N. Firmina, et al. (2022) on the Use of the Autoregressive Integrated Moving Average (ARIMA) Model to Forecast the Farmer Exchange Rate (NTP) in North Sulawesi Province, which found that the NTP from August 2021 to December 2021 increased slowly each month. Then, research by Pradana Saiful et al. (2020) on forecasting the Farmer Exchange Rate in Lamongan Regency using ARIMA found that food crops had a low NTP value, averaging ≥100 each month over a 3-year period, with the highest NTP decline in 2019 at 10.25%. and a study by Saraba Katadi et al. (2024) researched the Analysis of Farmer Exchange Rate Trends Across Agricultural Subsectors in North Sulawesi Province using trend analysis with the least squares method, with the results showing that the highest increase was in the plantation subsector. The subsector with the lowest decrease was the livestock subsector.

Based on the above studies, the author is interesting in researching the forecasting of the farmer's exchange rate (NTP) for the food crop subsector in North Sumatra for 2025-2027 using the ARIMA method. The ARIMA method was chosen because it can forecast all types of data patterns, although it requires a differentiation process to produce stationary data (Nofiyanto et al., 2015), resulting in more accurate short- and medium-term forecasts, and is suitable for time series data such as the farmer exchange rate to be researched. The results of the NTP forecasts for the food sub-sector can serve as a policy guideline for the government in anticipating future situations to improve the food farmers' exchange rate in North Sumatra. It is hoped that the NTP the food crop subsector will rise above 100 percent to be categorized as prosperous. Therefore, the objective of

this study is to analyze the forecasting and describe the results of the forecasting of the food sub-sector NTP in North Sumatra for the years 2025-2027.

2. Methods

Forecasting analysis is developmental research that studies patterns over time (Makridakis, 1999). The data for this research is secondary data in the form of a time series, namely actual data on farmer exchange rate for the food crop subsector in North Sumatra from January 2020 to December 2024 reaching 60 data. Secondary data was obtained from the Central Statistics Agency of North Sumatra. The data analysis methods in this research are descriptive analysis and econometric analysis, as follows:

2.1. Descriptive Analysis

Simple analysis is used to describe an observed data condition and is presented in the form of graphs, tables and narratives aimed at making it easier for readers to describe the results of observations of forecasting farmer exchange rate for the food crop subsector in North Sumatra from 2025 to 2027 using Microsoft Excel software.

2.2. ARIMA method

ARIMA model (p,d,q) where p is the AR order, q is the MA order, and d is the number of differencing ($d \leq 2$). The most important requirement for the ARIMA method is that the data is stationary.

This research uses Minitab 17 software with the following stages:

1. Identifying whether the data is stationary in variance and mean. If the data is not stationary in variance, a transformation is applied, and if it is not stationary in mean, differencing is applied
2. Creating ACF and PACF graphs from the stationary data
3. Determining the appropriate ARIMA model based on the ACF and PACF graphs
4. Estimating the significance test, MSE, and SSE from several selected parameter models
5. Choosing the best model based on the smallest MSE and SSE values
6. Forecasting the exchange rate for the food crop subsector for several periods in the future from January 2025 to December 2027.

3. Results and Discussion

3.1. Data Identification

An overview of NTP movements in the food sub-sector in North Sumatra for the period January 2020 to December 2024 is shown in Figure 1.

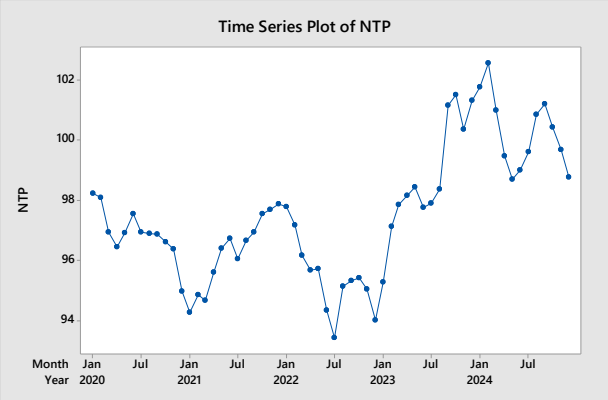


Figure 1 Graph Time series Plot of the food crop subsector NTP

Figure 1 shows that NTP data for the food subsector in North Sumatra tends to increase significantly from mid-2022 to mid-2024, followed by a small decline thereafter, which indicates that the mean of the data changes over time, meaning that the data is not stationary in terms of mean. Additionally, the variance in the data shows a fluctuating or changing pattern, meaning that the data is not stationary in value of variance.

3.2. ARIMA Analysis

3.2.1. Stationarity Test

Based on Figure 1, it can be seen that the NTP data used is not stationary in terms of mean and variance because it is not constant from time to time. Therefore, data transformation and differencing are required to obtain stationary data. A fairly easy technique for transforming and differencing the data is to use the Box-Cox transformation function and the difference feature in Minitab software. The Box-Cox transformation plot is shown in Figures 2 and 3.

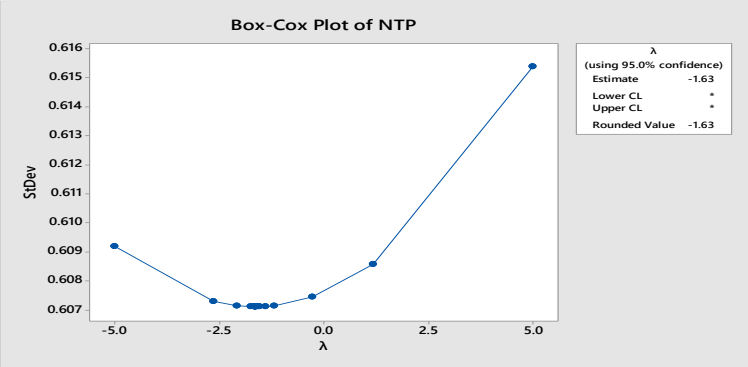


Figure 2 Transformation Box-Cox of the food crop subsector NTP

Based on Figure 2, the results of the first transformation of the food crop subsector NTP are not yet stationary in variance because the test results show that the value of λ = -0.163, so the data needs to be transformed to make it stationary in variance.

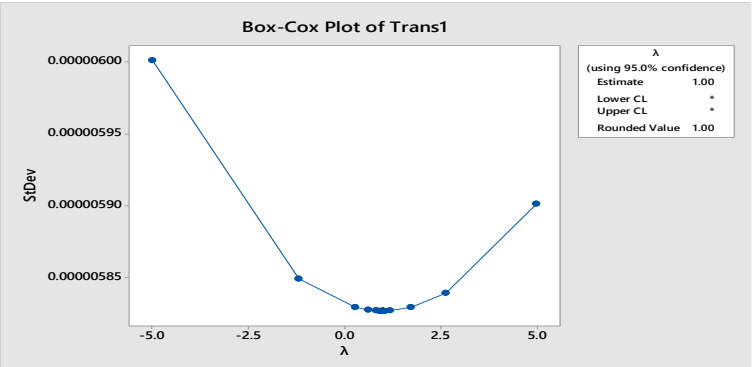
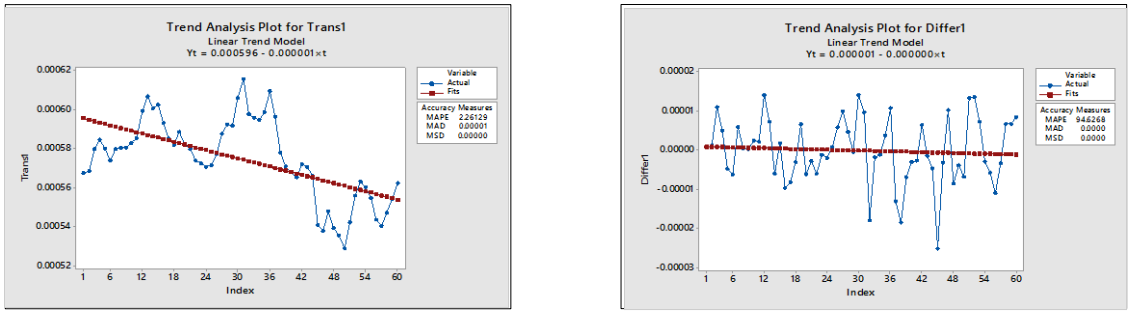


Figure 3 Transformation Box-Cox of the food crop subsector NTP

After the second transformation, the food crop subsector NTP can be said to be stationary in variance because the test results show that the value of λ=1 as shown in Figure 3, because the data is said to be stationary in variance if the Rounded Value is 1 (Khoiri, 2023).



(a) (b)

Figure 4 Figure Results : (a) Before Differencing; and (b) After Differencing

Based on Figure 4 part (a), the graph of the data that has been transformed with the help of trend analysis still shows a downward trend line, indicating that the data is still not stationary in terms of mean and requires differencing 1, while figure (b) shows that the NTP data for the food crop subsector is stationary in mean because the trend line on the graph is flat, indicating that the average value is constant.

3.2.2. Determining the Model

Model identification is the stage of searching for estimates or approximations of model parameter orders based on ACF and PACF plots on stationary data in variance and mean. The results of this process are used to model ARIMA (p,d,q) on the tested data.

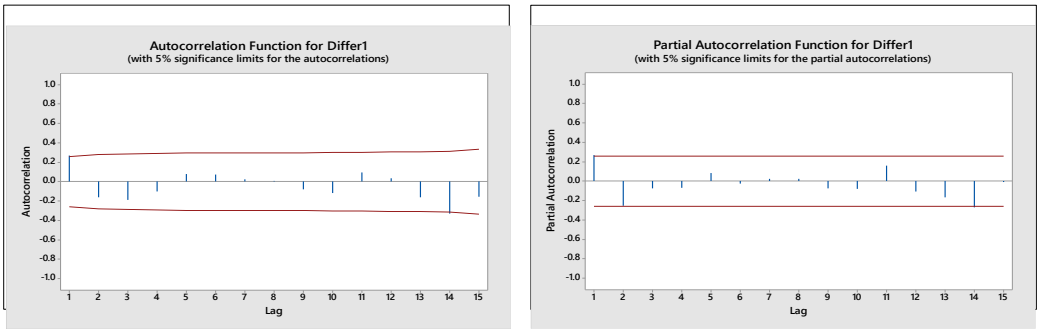


Figure 5 *Correlogram* ACF dan PACF After Differencing 1

Based on Figure 5, it can be seen that there is a sharp decline in each lag in the ACF and PACF correlograms, indicating that the data is stationary. This can be seen from the lag that falls outside the confidence interval of no more than 3 (Radjabaycole et al., 2021). From the ACF plot, it can be seen that there is a lag that falls outside the bounds, namely lag 1, while from the PACF plot, it can be seen that there are lags that fall outside the bounds, namely lag 1 and lag 2. Since the data has undergone a single differencing process, the value of d = 1. The resulting ARIMA models are ARIMA (2,1,0), (1,1,1), (0,1,1), and (1,1,0)

3.2.3. Model Estimation and Significant Test

ARIMA model parameter estimation can be performed using a trial and error approach, namely by testing several different values and selecting the value that produces the smallest residual sum of squares with the help of Minitab software. The significant test to see whether the model is suitable for use with the hypothesis proposed in this test is as follows (Panjaitan et al., 2023).

H_0: parameter ≠ 0 (significant)

H_1: parameter = 0 (not significant)

The decision criterion is that H_0 will be rejected if the p-value < α, where α = 0.05. The results of the ARIMA model estimation and significance test can be seen in Table 1 below.

Table 1 ARIMA Model Estimation and Significant Test

Model	Parameter	*P-Value*	Keterangan
ARIMA (2,1,0)	AR (1)	0.001	Significant
	AR (2)	0.011	Significant
ARIMA (1,1,1)	AR (1)	0.531	Not Significant
	MA (1)	0.043	Significant
ARIMA (0,1,1)	AR (1)	0.002	Significant
ARIMA (1,1,0)	MA (1)	0.035	Significant

Source: Data Processed by Minitab 17 (2025)

Based on Table 1, it is known that the ARIMA (2,1,0), (0,1,1) and (1,1,0) models are significant, so these models are suitable for the stage of determining which model has the smallest MSE and SSE values.

3.2.4. Selecting the Best Model

The next step is to determine the best model by looking at the smallest MSE and SSE values using the Minitab 17 application.

Table 2 Results Output Minitab Residual Sums of Squares

Model	MSE	SSE
ARIMA (2,1,0)	0.4110	37.8152
ARIMA (0,1,1)	0.6828	38.9209
ARIMA (1,1,0)	0.7107	40.5106

Source: Data Processed by Minitab 17 (2025)

Based on Table 2, it can be seen that the MSE value of 0.4110 and SSE of 37.8152 for the ARIMA (2,1,0) model are smaller than the MSE and SSE values of the ARIMA (0,1,1) and ARIMA (1,1,0) models. So, the ARIMA model that will be used to forecast the NTP for the food crop subsector in North Sumatra is the ARIMA (2,1,0) model.

Table 3 Results of NTP Forecasting for the Food Crop Subsector (Percent)

Bulan	Tahun		
	2025	2026	2027
Januari	98.6597	99.1239	99.3270
Februari	98.8856	99.1408	99.3439
Maret	99.0061	99.1577	99.3608
April	99.0032	99.1746	99.3778
Mei	98.9857	99.1916	99.3947
Juni	98.9960	99.2085	99.4116
Juli	99.0198	99.2254	99.4285
Agustus	99.0408	99.2423	99.4455
September	99.0574	99.2593	99.4624
Oktober	99.0731	99.2762	99.4793
November	99.0897	99.2931	99.4962
Desember	99.1068	99.3100	99.5132

Source: Data Processed by Minitab 17 (2025)

3.2.5. Description of Forecast Results

Figure 6 shows the movement of the NTP for the food crop subsector in North Sumatra from January 2020 to December 2027.

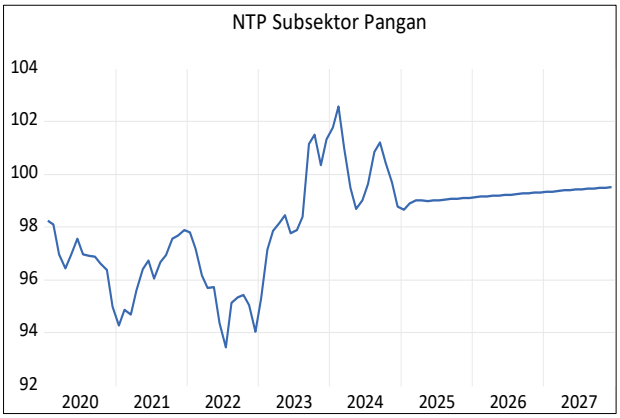


Figure 6 Graph NTP for The Food Crop Subsector 2020-2027

Based on Figure 6, the forecast from January 2025 to December 2027 shows an increasing trend, but the exchange rate for farmers in the food crop subsector is still below 100 percent (NTP < 100) indicates that farmers will experience a deficit, where the price index received by farmers is derived from their agricultural income, which is lower than the price index paid by farmers, determined by their expenditures to meet household consumption and the costs of additional capital goods for their agricultural operations.

In conclusion, farmers have not yet achieved welfare in the 2025-2027 range, just like in the 2020-2023 range, which is still below 100 percent. In 2024, there has been an increase, but the NTP is still equal to 100, meaning that farmers have not experienced any changes or are at a break-even point. Based on the forecast results, in the future, the government should focus more on developing policies that impact the welfare of food crop farmers, particularly in North Sumatra, to ensure the sustainability of food crops in

Indonesia. This requires policy interventions from the government, including policies related to farmers' household income and policies related to farmers' household expenditures.

4. Conclusions

Based on the analysis and discussion, it can be concluded that the best forecasting method for predicting the NTP of the food subsector in North Sumatra for the years 2025-2027 is ARIMA (2,1,0) because it has the smallest MSE value of 0.4110 and SSE value of 37.8152 compared to other models, with the forecast results showing an upward trend. The NTP forecasts for the food sub-sector in North Sumatra from January 2025 to December 2027 are still below 100 percent, indicating that food crop farmers in North Sumatra have not yet achieved welfare.

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