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FORECASTING OF PALM OIL FRUIT FRESH BUNCHES (FFB) PRICES IN NATIONAL AND BENGKULU PROVINCE: ARIMA MODEL APPLICATION

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ABSTRACT

CPO price fluctuations that occur also have an impact on the price of palm oil FFB at the National and Bengkulu Province. Because, palm oil is the raw material for making CPO. This study aims to determine the best ARIMA model for predicting the price of palm oil FFB at the National and Bengkulu Province, as well as to find out the results of forecasting palm oil prices at the National and Bengkulu Province in 2021. This study uses secondary data, namely monthly data from palm oil producer price data national and Bengkulu Province in 2011-2020. The model used for this research is ARIMA. The results of the study show that models are suitable for forecasting at the National and Bengkulu Province, namely ARIMA (2,1,8) and ARIMA (2,1,7). The results of forecasting the highest national oil palm FFB price occurred inin January 2021 of Rp. 118,075/100 kg and the lowest national palm oil FFB price occurred in December 2021 of Rp. 115,696/100 kg. while the results of forecasting the highest price of oil palm FFB in Bengkulu Province occurred in December 2021 amounting to Rp.148,653/100 kg and the lowest price of oil palm FFB in Bengkulu Province occurred in January 2021 amounting to Rp.144,798/100 kg.

Keywords: *forecasting, oil palm, ARIMA models*

BACKGROUND

Palm oil is plants obtained from plantations that are processed into CPO or other. CPO is a source of vegetable oil that is needed by the community because the results of oil palm plantations are used as a primary need for the community which results in the production of soap, cooking oil, and others. By making it a basic need, the community needs to increase palm oil production so that the community's needs for utilizing palm oil can be fulfilled. The wider the oil palm plantation owned by the oil palm farming community, the higher the income earned by the oil palm farming community. This condition has caused many people to shift their agriculture to oil palm plantations (see for example Charters et al., 2019 and Daulay et al., 2016).

As a world CPO producing country, Indonesia is the largest CPO exporting country in the world. In 2020 the development of Indonesia's CPO export prices continues to increase from the previous year. Indonesia's CPO export price in 2020 reached US$ 17,363,921 million, an increase of 18% compared to the previous year which reached US$ 14,716,275 million. Oil palm FFB production in Indonesia tends to increase. Indonesia's total FFB production fluctuated from 2011 to 2020. In

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Vol 7 (1): 194-202, March 2023

2020, the average FFB production reached 48.2 milliontons, an increase of 2.5% compared to the price of palm oil FFB in 2019, which was 47.1 million tons. The largest FFB production in Indonesia is in Bengkulu Province, reaching 1,063.40 thousand tons in 2020, an increase of 3.0% compared to the price of palm oil FFB in 2019, namely 1,032.10 thousand tons (BPS, 2021).

Seeing the development of Indonesia's CPO exports, the fluctuations in CPO prices that have occurred have attracted attention. This fluctuation in the price of Indonesian CPO also has an impact on the price of palm oil FFB. Because, FFB is the raw material for making CPO. The development of the national palm oil FFB price fluctuates every year. Based on data from BPS, in the last 10 years, namely 2011-2020, there has tended to be an increase, but from 2018 to 2020, the price of FFB has tended to decrease. Likewise, the development of the price of oil palm FFB in Bengkulu Province tends to increase but has decreased from 2017 to 2020.

Following the findings of Voituriez (2001), fluctuations in the price of palm oil FFB cansuspected also occurs due to several factors. The first factor is demand, based on the sound of the law of demand, namely when the price of a product is higher, the demand for a product is lower. Conversely, when the price of a product is lower, the demand for a product is higher. The second factor is supply, where the law of supply sounds, namely when the price of a product offered increases, producers will increase the number of products offered. Conversely, when the price of a product decreases, producers tend to reduce the number of products offered.

Based on the phenomenon of price fluctuations above, it is very important to predict future prices. Forecasting is a statistical method that plays an important role in determining decisions to increase competitiveness in world markets. Forecasting aims to predict what will happen in the future based on historical data (Makridakis, 2002). The method used for forecasting is the ARIMA method. In 1976, George Box and Gwilym Jenkins introduced the ARIMA method. In fact, the names George Box and Gwilym Jenkins are often equated with the ARIMA process which is applied in time series analysis, forecasting and control (Wirayasa, 2020).

Several studies have also found that the ARIMA model is the best model used in forecasting. This research was conducted by Sukiyono et al., (2018) on cocoa commodity, Novanda et al., (2018) on coffee commodity, Akolo (2019) on rice production, Sukiyono et al., (2019) on rubber commodity, Sukiyono et al., (2021) on FFB and CPO prices, Guleryuz (2021) regarding the Covid-19 outbreak, and Pitaloka (2019) regarding forecasting import values shows that the ARIMA model is quite accurate in forecasting data. Therefore, this study aims to determine the best ARIMA model and apply it for forecasting the price of oil palm FFB, both at the Indonesian level and at the Bengkulu Province level. The best model found in this studyexpected toused as a tool to predict the price of FFB in the next period so that business actors and stakeholders can prepare actions or policies related to the price of palm oil FFB. On the other hand, the best model selection technique can be applied to other commodity prices.

RESEARCH METHODS

The location of this research was determined purposively, namely the National and Bengkulu Province with consideration that the National and Bengkulu Province are one of the areas that have oil palm FFB plantations which are quite extensive and most of the farmers make their living in oil

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 7 (1): 194-202, March 2023

palm plantations. Data that used in this research is monthly data price FFB Palm oil in level national and Bengkulu Province in 2011:1-2020:12 obtained from BPS Indonesia.

Data Analysis Method

Stationarity Testing

Stationary testing is carried out to estimate the stationarity of time series data. Stationarity testing is very important to avoid spurious regression. In analyzing the stationarity estimation data can be analyzed with the Augmented Dickey-Fuller test(ADF) (Elvina et al, 2017). The equation for the stationary test can be seen as follows:

$$\Delta P_t = a0 + t\text{-}1 + 1t\text{-}i+1 + t\gamma P \sum_{i=1}^{j} a\, \Delta P\varepsilon$$

Information:

Pt : Price data for period t
j : Lag length
ε : Error

Autoregressive (AR) Models

The amount of time series data used in the AR model is better known as the p order. In the AR model this must meet the requirements by following the stationarity of the data, where the overall coefficients in the AR model must be less than 1. The equations in the AR model can be seen as follows (Firdaus, 2020):

$$zt = \mu + \Phi_1 BZt + \Phi_2 B2Zt + \Phi_3 B3Zt + \ldots + pBpZt + t\Phi\varepsilon$$

Information:

Zt : Price data for period t
Zt-1, Zt-2 : Price data for the previous period
1, 2$\mu\Phi\Phi$: Constants and coefficients AR
ε_t : Error value at time t

Moving Average (MA) Models

The amount of time series data used in the MA model is better known as the q order. In the MA model this must meet the requirements whereby the overall coefficients in the MA model must be less than 1. The equations in the MA model can be seen as follows (Firdaus, 2020):

$$zt = \mu + \varepsilon_t - 1t\text{-}1 - 2t\text{-}2 - \ldots qt\text{-}q\Theta\varepsilon\Theta\varepsilon\Theta\varepsilon$$

Information:

Zt : Price data for period t
ε_t : Residual forecasting period t
ε_{t-1},t-2 ε : Residual forecasting period previously
$\mu, \Theta_{1,2}\Theta$: MA constants and coefficients

Autoregressive Integrated Moving Average (ARIMA) Model

The amount of time series data used in the ARIMA model is better known as the order (p,d,q). The general form of the ARMA model process can be written as follows (Firdaus, 2020):

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 7 (1): 194-202, March 2023

$$zt = \delta+1Zt-1+2Zt-2+\ldots+t\text{–}1t\text{-}1\text{–}2t\text{-}2\ \text{-}\ldots\text{-}qt\text{-}q\Phi\Phi\varepsilon\Theta\varepsilon\Theta\varepsilon\ \Theta\varepsilon$$

Information:

Zt	: Price data for period t
Zt-1, Zt-2	: Period forecasting data previously
ε_{t-1},t-2 ε	: Residual forecasting period previously
ε_t	: Residual forecasting period t
δ, 1, 2, 1, 2	: Constants and coefficients
-ΦΦΘΘ	: Model coefficients

Selection of the best model is carried out after the palm oil price data is analyzed using the ARIMA forecasting technique. In selecting the best model, the authors used the trial and error method by comparing the smallest MAE, RMSE, and MAPE values. According to Firdaus (2020) explains that there are various measures of forecasting model accuracy, namely, MAE (Mean Absolute Error), RMSE (Root Mean Squared Error), and MAPE (Mean Absolute Percentage Error).

RESULT AND DISCUSSION

Descriptive Statistics of Oil Palm FFB Prices

In Table 1. It can be seen that the national average price of palm oil from 2011 to 2020 tends to experience a significant increase. The highest increase occurred in 2013 to 2014. In 2014, the highest price of palm oil was Rp. 146,445/100 kg with a standard deviation of 3,791.80. Meanwhile, the average price of palm oil in Bengkulu Province from 2011 to 2016 has increased. However, from 2017 to 2020 the average price of palm oil in Bengkulu Province has decreased by Rp. 133,102/100 kg with a standard deviation of 7,922.07. The highest price of palm oil occurred in 2016, which was Rp. 145,248/100 kg with a standard deviation of 9,931.65.

Table 1. Descriptive Data for Oil Palm FFB Prices/100 kg in 2011-2020.

Variable	Year	Average	Standard Deviation	Maximum	Minimum
National	2011	110,522	1,487.03	113,286	108,591
	2012	120,769	1,552.96	123,476	118,643
	2013	125,041	2,831.71	129,341	120,394
	2014	146,445	3,791.80	151,069	140,569
	2015	135,629	10,679.40	147,919	120,123
	2016	147,723	10,611.04	162,432	125,161
	2017	123,315	3,481.01	127,522	117,820
	2018	108,874	12,712.28	122,495	88,438
	2019	101,383	6,397.65	116,387	91,969
	2020	117,013	6,330.98	128,651	107,828

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 7 (1): 194-202, March 2023

	2011	71,752	11,473.80	88,934	53,301
	2012	92,470	16,321.90	105,604	60,272
	2013	107,636	5,312.69	113,532	97,572
	2014	126,801	6,969.01	138,151	111,520
Bengkulu Province	2015	134,260	15,614.44	153,692	109,098
	2016	145,248	9,931.65	156,036	119,549
	2017	133,102	7,922.07	143,226	118,108
	2018	112,557	11,415.45	128,506	97,832
	2019	107,661	11,128.88	131,742	93,164
	2020	140,714	10,333,21	159,118	128,546

Source: Processed Secondary Data, 2022

Based on Table 1. National prices for palm oil fluctuate every month, ranging from Rp. 88,000-162,000/100 kg. The highest National price of palm oil was Rp. 162,432/100 kg in December 2016 and the lowest price in the National was Rp. 88,438/100 kg in December 2018. Meanwhile, the price of palm oil in Bengkulu Province fluctuated every month ranging from Rp. 153,000-159,000/100 kg. The highest price for palm oil in Bengkulu Province occurred in December 2020, namely Rp. 159,118/100 kg. Meanwhile, the lowest price occurred in December 2011 with a price of Rp. 53,301/100 kg of palm oil. The increase and decrease that occurs is caused by the number of requests. In 4 July 2018, for example, reported that the European Union boycott was suspected to be the reason for the downward CPO price fluctuations which had an impact on the price of FFB at the farm level. Other reports also stated that the large number of CPO stocks was the reason for the decrease in FFB prices (Fauzan, 2022).

Data Stationarity Check

The phase of checking the stationarity of the data needs to be done so that the data used is stationary. According to Rahmawati et al. (2019) if the data being analyzed is not stationary, it can perform differencing data. The ADF test results are said to be stationary if the probability value is <alpha.The following are the results of stationarity testing of oil palm FFB price data.

Table 2. ResultsAugmented Dickey-Fuller (ADF) Test.

Variable	Levels	Conclusion	*First Difference*	Conclusion
National	0.3635	Not Stationary	0.0000	Stationary
Bengkulu Province	0.2513	Not Stationary	0.0000	Stationary

Source: Processed Secondary Data, 2022

The probability value at the level generated by the ADF test from the National variable is 0.3635. This means that the probability value is greater than 0.05 so that the National data at the level cannot be said to be stationary and it is necessary to perform data differencing. Based on the results of the data at the first difference level it is stationary where the probability value is less than 0.05, namely 0.0000. This also occurs in the Bengkulu Province variable, where the probability value at the level level is greater than 0.05, namely 0.2513 so that the data on the Bengkulu Province variable is not stationary and needs to do differencing data. Based on the results after differencing the data at

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 7 (1): 194-202, March 2023

the first difference level, the probability value obtained is 0.0000, so that the data on the Bengkulu Province variable at the first difference level can be said to be stationary.

Best Model Selection

Table 3 present results recapitulation of several ARIMA models with MAE, RMSE, and MAPE values of each model.

Table 3. MAE, RMSE, and MAPE Value Forecasting Oil Palm FFB Prices.

Forecasting Models	Forecasting Accuracy			Conclusion
	MAE	RMSE	MAPE	
National				
ARIMA (2,1,4)	12094.47	14512.01	10.23022	
ARIMA (2,1,5)	11957.65	14394.52	10.07840	
ARIMA (2,1,6)	11973.73	14408.54	10.10240	
ARIMA (2,1,7)	11875.05	14345.16	9.961990	
ARIMA (2,1,8)	**11806.60**	**14320.41**	**9.859185**	Best Models
ARIMA (2,1,9)	13078.48	17362.44	10.45979	
ARIMA (2,1,10)	15361.81	192272.7	11.98582	
ARIMA (2,1,11)	15527.94	19361.64	12.19488	
ARIMA (2,1,12)	15549.70	19372.53	12.22191	
Bengkulu Province				
ARIMA (2,1,3)	15818.47	20174.64	15.22083	
ARIMA (2,1,4)	16028.81	20650.25	15.50180	
ARIMA (2,1,5)	19597.18	23179.05	17.23255	
ARIMA (2,1,6)	19677.53	23278.94	12.32164	
ARIMA (2,1,7)	**15646.86**	**19868.86**	**15.03657**	Best Models
ARIMA (2,1,8)	19797.33	23336.98	17.39904	
ARIMA (2,1,9)	19524.71	23187.47	17.24655	
ARIMA (2,1,10)	23997.85	31446.59	21.53536	
ARIMA (2,1,11)	20876.79	27463.25	18.73716	

Source: Processed Secondary Data, 2022.

Based on the calculation of the accuracy of the national palm oil price forecasting model, the ARIMA forecasting model (2,1,8) is the most suitable forecasting model in providing forecast results for the national palm oil price. The best model can be seen from the accuracy value of the forecasting model MAE, RMSE, and, the smallest MAPE. The resulting national palm oil price forecasting accuracy is an MAE value of 11806.60, an RMSE value of 14320.41, and a MAPE value of 9.859185%. While calculating the accuracy of the Bengkulu Province palm oil price forecasting model, each indicator that has the smallest MAE, RMSE, and MAPE values is found in the ARIMA model (2,1,7). The accuracy value of the MAE forecasting model is 15646.86, the RMSE value is 19868.86, and the MAPE value is 15.03657%.

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http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 7 (1): 194-202, March 2023

Oil Palm FFB Price Forecasting

The best model obtained based on the smallest forecasting accuracy value can carry out the next stage, namely forecasting. Forecasting the price of palm oil in the National market and Bengkulu Province is carried out to predict prices for the next one year, from January 2021 to December 2021. Prices used to predict prices are actual prices, namely in 2011 to 2020. In Table 4. You can see the results of forecasting the price of palm oil FFB at the National and Bengkulu Province levels based on the best model chosen to predict palm oil prices at the National and Bengkulu Province levels in 2021.

Table 4. Forecasting Results for National and Bengkulu Province Oil Palm FFB Prices in 2021.

Month	National		Bengkulu Province	
	Actual	Forecasting	actual	Forecasting
January	138130	118075	159118	144798
February	138732	117857	159137	145149
March	144047	117643	167458	145499
April	147194	117425	167335	145849
May	151219	117211	171418	146200
June	151981	116993	162735	146550
July	150756	116778	163603	146901
August	158730	116561	172323	147251
September	165945	116346	180925	147601
October	174031	116128	190142	147952
November	187070	115914	198436	148302
December	193490	115696	198761	148653

Source: Processed Secondary Data, 2022

Based on the table, it can be seen that the results of the National and Bengkulu Province palm oil price forecasts can be said to be feasible. This is because the comparison of actual data with forecasting data has not much different. According to Putri et al. (2018) in proving the accuracy of a forecast, it can be seen from the MAPE value where the criteria for a MAPE value of 10% <20% MAPE can be said to have good forecasting accuracy. The forecast for the next 12 periods also shows that the national palm oil price is experiencing a trend that tends to continue to decline every month. The results of forecasting the National price of palm oil from January to December 2021 range from Rp. 115,000-118,000/100 kg. The highest National price of palm oil occurred in January 2021 of Rp. 118,075/100 kg and the lowest National price of palm oil occurred in December 2021 of Rp. 115,696/100 kg.

Meanwhile, the price of palm oil in Bengkulu Province for 2021 shows that the price of palm oil FFB tends to increase every month. It is predicted that the price of palm oil in Bengkulu Province will begin to experience an increase in prices from January to the end of December 2021, ranging from Rp. 144,000-148,000/100 kg. Forecasting the highest price of Bengkulu Province palm oil will occur in December 2021, which is Rp. 148,653/100 kg. Meanwhile, the forecast for the lowest palm oil price for Bengkulu Province will occur in January 2021, namely Rp. 144,798/100 kg. One of the factors causing fluctuations in national and Bengkulu province palm oil prices is CPO prices.

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http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 7 (1): 194-202, March 2023

According to Mulyani (2021) changes in the price of palm oil FFB that occur are influenced by the price of Crude Palm Oil (CPO). Severy price increase in CPO will follow by increase in the price of palm oil FFB. Conversely, if the price of CPO decreases, the price of FFB will decrease.The findings of this data indicate that price formation is at least not influenced by previous prices, but also by other factors. The findings of Flemming et al. (2007), for example, indicate that price is most sensitive to the quantity supplied to both export and domestic markets. Furthermore, Gonzalez-Rivera & Helfand (2001), said that the formation of prices for agricultural products is influenced by the size, pattern of integration, and the level of integration of the market.

CONCLUSION AND SUGGESTION

The smallest acquisition of MAE, RMSE, and MAPE results is the forecasting best model that can be used for national palm oil prices is ARIMA (2,1,8) for the price of palm oil in Bengkulu Province, ARIMA models (2,1,7) is the best ARIMA model base on lowest MAE, RMSE, and MAPE values. The results of the National CPO price forecasting for 2021 will decrease with the highest National CPO price forecast occurring in January 2021 of Rp. 118,075/100 kg and the lowest National CPO price occurring in December 2021 of Rp. 115,696/100 kg . Meanwhile, the results of forecasting the price of palm oil in Bengkulu Province for 2021 tend to experience a trend element which tends to increase every month. The price for saiwt coconut in Bengkulu Province occurs in December 2021, which is Rp. 148,653/100 kg. Meanwhile, the forecast for the lowest price of palm oil in Bengkulu Province will occur in January 2021, namely Rp. 144,798/100 kg.

REFERENCES

Akolo, I., R. 2019. Comparison of Holt-winter Exponential Smoothing and ARIMA in Forecasting Rice Production in Gorontalo Province. Technopreneur Journal (JTech), 7(1), 20-26.

[BPS] Central Bureau of Statistics. 2021. Indonesian Palm Oil Statistics 2020. Jakarta (ID): Central Bureau of Statistics.

Charters, Lewis J. Paul Aplin, Christopher G. Marston, Rory Padfield, Nagarajan Rengasamy, Mohd Puat Bin Dahalan & Stephanie Evers (2019) Peat swamp forest conservation withstands pervasive land conversion to oil palm plantation in North Selangor, Malaysia, International Journal of Remote Sensing, 40:19, 7409-7438, DOI: 10.1080/01431161.2019.1574996

Daulay, Asnelly Ridha, KP Eka Intan, Baba Barus, N. Bambang Pramudya, (2016) Rice Land Conversion into Plantation Crops and Challenges on Sustainable Land Use System in the East Tanjung Jabung Regency, Procedia - Social and Behavioral Sciences, 227: 174 - 180, https://doi.org/10.1016/j.sbspro.2016.06.059.

Elvina, Muhammad Firdaus, & Anna Fariyanti. 2017. Price Transmission and Sequential Bargaining Game of Market Behavior Between Red Chili Marketing Agencies in Indonesia. Indonesian Agribusiness Journal (Journal of Indonesian Agribusiness), 5(2):89-110.

Fauzan, Mochamad Rizky (Monday, 11 July 2022) The price of FFB for palm oil has fallen, this is the reason. Accessed from https://www.inews.id/finance/business/harga-tbs-sawit-anjlok-ini-pembebabnya.

Firdaus, M. 2020. Econometric Applications with E-Views, Stata, and R. PT IPB Press Publisher: Bogor.

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
Vol 7 (1): 194-202, March 2023

Flaming, Stephen & Marsh, Thomas & Wahl, Thomas. (2007). Farm-Level Price Formation for Fresh Sweet Cherries. Journal of Food Distribution Research. 38.

González-Rivera, Gloria and Helfand, Steven M., (2001) The Extent, Pattern, and Degree of Market Integration: A Multivariate Approach for the Brazilian Rice Market (August 2001). American Journal of Agricultural Economics, 83(3):576-592, http://dx.doi.org/10.1111/0002-9092.00179

Guleryuz, D. 2021. Forecasting Outbreak of COVID-19 in Turkey; Comparison of Box-Jenkins, Brown's Exponential Smoothing and Long Short-term Memory Model. Process Safety and Environmental Protection, 149, 927-935.

Makridakis, S., Wheelwright, SC, & McGee, VE 2002. Application And Forecasting Methods. Binarupa Script Publisher. Jakarta.

Mulyani. 2021. Price Analysis of Oil Palm Fresh Fruit Bunches in Jambi Province. Journal of Agricultural Economics and Agribusiness, 5(2), 315-322.

Novanda, Ridha Rizki, et al. 2018. A Comparison of Various Forecasting Techniques For Coffee Prices. Journal of Physics: Conference Series, 1114(2018) 012119.

Pitaloka, et al. 2019. Comparison of the Box-Jenkis ARIMA Method with ARIMA Ensemble in Forecasting Import Value of Central Java Province. Gaussian Journal, 8(2), 194-207.

Putri, Maria Cendanasari Kurniawan., & Wiwik A. 2018. Application of the Mixed Method of Autoregressive Integrated Moving Average and Quantile Regression (ARIMA-QR) for Chili Price Forecasting as a Strategic Indonesian Agricultural Commodity. ITS Engineering Journal. 7(1): 132-137.

Rahmawati, Sri Wahyuningsih, & Syaripuddin. 2019. Forecasting the Rate of Oil Production in the Province of East Kalimantan Using the DCA and ARIMA Methods. Journal of Statistical Application and Computational Statistics, 11 No 1, 73-86.

Sari, Yolanda., & Winarni Ethics. 2022. Comparison of Exchange Forecasting Performance in Indonesia. Economical; Journal of Economics and Business, 6(1), 60-68.

Palm Notif, (4 July 2018). This is the Cause of the Drop in the Price of Palm Oil FFB. Accessed from https://pkt-group.com/sawitnotif/inilah-pembebab-harga-tbs-kelapa-sawit-anjlok/

Sukiyono, Ketut., Musriyadi Nabiu, Bambang Sumantri, RR Novanda, Nyayu N. Arianti, Sriyoto, MM Zulkarnain Yuliarso, Redy Badrudin, M. Mustopa Romdhon, H. Mustamam. 2018. Selecting an Accurate Cacao Price Forecasting Model. Journal of Physics: Conf. Series 1114 (2018) 01211.

Sukiyono, Ketut., Nusril, Eko Sumartono, Indra Cahyadinata, M. Zulkarnain Yuliarso, Gita Mulyasari, Musriyadi Nabiu, Febrina Nur Annisa. 2019. Possible Method for Monthly Natural Rubber Price Forecasting. Journal of Advanced Research in Dynamic Systems and Controls-Jardcs, 11, 387-395.

Sukiyono, K., Arianti, NN, Sumantri, B., Mustopa Romdhon, M. and Suryanty, M. (2021) "A Model Selection For Price Forcasting Of Crude Palm Oil And Fresh Fruit Bunch Price Forecasting", Iraqi Journal Of Agricultural Sciences, 52(2), pp. 479–490. doi: 10.36103/ijas.v52i2.1312.

Wirayasa, I Ketut Agus. 2020. Forecasting the Amount of Rice Production in East Luwu Regency Using the ARIMA Model. Thesis. Cokroaminoto Palopo University. South Sulawesi.

Voituriez, T. (2001), What explains price volatility changes in commodity markets? Answers from the world palm-oil market. Agricultural Economics, 25: 295-301. https://doi.org/10.1111/j.1574-0862.2001.tb00209.x