Electronic Research Journal of Social Sciences and Humanities
ISSN: 2706 – 8242 www.eresearchjournal.com
Vol 6: Issue I
Jan-Mar 2024

Analysis of the Best Forecasting on Cocoa Production and Imports in Indonesia in 2022-2026 using the Triple Holt-Winters and ARIMA Methods

Andereas Siagian[1]
Student of the Agribusiness Master's Study Program, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia
Email: andereassiagian@gmail.com

Tavi Supriana
Agribusiness Masters Study Program, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia
Email: tavi@usu.ac.id

Iskandarini
Agribusiness Masters Study Program, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia
Email: iskandarini@usu.ac.id

Abstract

This research reviews the best forecasting analysis of cocoa production and import in Indonesia from 2022-2026 using the Triple Holt-Winters and ARIMA methods. This research aims to analyze and choose the best method, to determine the results of forecasting cocoa production and import and to describe the results of forecasting cocoa production and import in Indonesia from 2022 to 2026. This type of research is developmental research, which studies patterns or sequences of changes over time. The secondary data are in the form of a time series and are univariate, namely actual data on cocoa production and import from January 2017 to December 2021 with a total of 120 data. In this research, both descriptive analysis and econometric analysis were conducted. The econometric analysis includes time series data forecasting methods using the Triple Holt-Winters and ARIMA methods. The results of the research show that the best forecasting method for cocoa production in Indonesia from 2022 to 2026 is the ARIMA $(1,0,1)(1,0,0)^{12}$ method with an RMSE value of 3781 while the best forecasting method for cocoa import in Indonesia from 2022 to 2026 is the ARIMA (1,0,0) method with RMSE values of 4563. The results of the forecasting analysis show that the volume of cocoa production from 2022 to 2026 will increase and the volume of cocoa import from 2022 to 2026 will increase in 2022, then there will be no change (constant) until 2026, so the implementation of several cocoa sustainability program policies will influence the increase in cocoa production which suppress import to Indonesia.

Keywords: cocoa; production; import; forecasting, Indonesia, 2022-2026, Triple Holt-Winters, ARIMA Methods

[1] Corresponding author

Introduction:

The cocoa plant stands as a pivotal national asset, marked for substantial development to bolster productivity, serving various domestic objectives such as meeting local demands, generating foreign exchange through exports, serving as alternatives to imported goods, and fostering employment opportunities across the production chain. According to statistics from Badan Pusat Statistik (2021), cocoa and its derived products rank as the third-largest contributor to foreign exchange earnings within the plantation subsector, amounting to approximately US$ 1.21 billion. Moreover, Indonesia plays a significant role in the global cocoa trade, contributing an average of 10 percent, as reported by FAOSTAT (2022).

Indonesia, currently ranked sixth among cocoa-producing nations according to ICCO (2021), boasts notable advantages in its cocoa industry, notably its cocoa's high melting point. This attribute renders Indonesian cocoa highly sought-after in the processing sector, particularly in the production of cocoa butter, crucially utilized in cosmetic and pharmaceutical applications as noted by Lubis and Nuryanti (2011). Indonesia holds the distinction of being the world's second-largest exporter of cocoa butter, accounting for 13.43 percent of global exports, following the Netherlands with a share of 26.42 percent, according to data from Badan Pusat Statistik (2018). Over the period spanning 2015 to 2020, Indonesian cocoa exports, encompassing cocoa beans, cocoa butter, cocoa paste, cocoa powder, and cocoa cake, amounted to a total value of 7 billion US dollars, as reported by FAOSTAT (2022). This export success is underpinned by Indonesia's robust cocoa processing industry, positioning it as the third-largest cocoa processing nation globally, trailing only the Netherlands and Ivory Coast, as highlighted by ICCO (2022).

Cocoa production witnessed a decline in 2018, dropping by 577,041 tons compared to 657,051 tons in 2017, and further decreased by 774,321 tons to 688,208 tons in 2019, as reported by Badan Pusat Statistik (2021). This decrease correlates directly with the reduction in land area from 1.65 million hectares in 2017 to 1.46 million hectares, attributed to infrastructure development or the conversion of cocoa plantation land into oil palm or rice fields (BPS, 2018). According to research conducted by the Swiss Business Hub Indonesia in 2019, Indonesia's per capita chocolate consumption in 2017 stood at 0.5 kg/year, with a national consumption growth rate of +10% per year in tons, whereas several European countries exhibited an average consumption of 10 kg/person per year. Despite increasing consumption trends, the cocoa industry faces challenges due to limited cocoa availability, leading to the need to import cocoa beans from various other countries, as highlighted by Jatim Newsroom (2020) and Mulyono (2017).

Cocoa imports over the last five years from 2017-2021 experienced an upward trend with an average of 4.17 per cent from 2017 of 226612 tonnes to 252122 tonnes in 2021 (Indonesian Cocoa Statistics, 2021). From the previous explanation, the future challenge for cocoa in Indonesia is the sustainability of cocoa production which affects the welfare of farmers and the supply of raw materials to the domestic cocoa processing industry. Cocoa problems that are often experienced by people's cocoa plantations are 98.92 per cent (BPS, 2021) such as lack of human resource capacity in cultivation, ageing of cocoa plants, attacks by cocoa pod borer (PBK) and vascular streak dieback (VSD). , as well as the lack of capital from farmers resulting in low application of fertilizer to cocoa plants which has an impact on reducing cocoa production and productivity (Karim et al., 2021).

In response to this challenge, the government implemented several cocoa sustainability program policies such as the National Movement for Increasing Cocoa Production and Quality Program (Gernas Kakao) in 2009-2013 with methods of cocoa rejuvenation, rehabilitation and intensification which were implemented in 25 provinces throughout Indonesia. The government also issued Minister of Agriculture Regulation Number 48/Permentan/OT.140/4/2014 of 2014 concerning Technical Guidelines for Good Cocoa Cultivation (Good Agriculture Practices/GAP on Cocoa). The Ministry of Agriculture's policy program for the next five years (2020-2024) includes setting targets to accelerate the increase in the size (volume and/or value) of exports of plantation products and their derivatives, known as the Triple Export Movement (Gratieks), which is supported by the implementation of the Production Increase Movement program, Added Value, and Competitiveness (Grasida).

Forecasting analysis can estimate the impact of implementing several cocoa sustainability program policies in the future (Abdoellah, 2021). In this research, the author analyzes the results of forecasting cocoa production and imports in 2022-2026 using the Triple Holt-Winters and ARIMA methods where the variable data studied is time series data and is univariate (one variable)(Firdaus, 2018). This research is also supported by several references to previous research using the same method as the latest research conducted by Handayani (2020) and Hasibuan (2023) with research on Comparison of Seasonal Time Series Forecasting Using Holt-Winters Exponential Smoothing and SARIMA (Study Case: Export Data West Sumatra) whose results show that the SARIMA method ((1,1,1)(0,1,1))12 with a MAPE value of 0.437% and MAD 78.821 is better than the Holt-Winter method with a MAPE value of 0.894% and MAD 163.320 (α=0.2, β=0.5, γ=0.1) so SARIMA is the best method for forecasting exports from January 2023 to December 2024 in West Sumatra (Rahman, Sumarjaya& Sukarsa, 2018).

From these two methods, the author will analyze and select the best forecasting method for the results of forecasting cocoa production and imports in 2022-2026 in Indonesia based on the smallest forecasting value and a description of the best forecasting results for cocoa production and imports in 2022-2026 so that this research is useful for the government and related agencies regarding the prediction data report on cocoa production and imports in 2022-2026, as information and reference material for further research in the same field.

Research 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 cocoa production and imports in Indonesia from January 2017 to December 2021 reaching 120 data. Secondary data was obtained from the Central Statistics Agency, Directorate General of Plantations, and other literature. The data analysis methods in this research are descriptive analysis and econometric analysis, as follows:

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 cocoa production and imports in Indonesia from 2022 to 2026 using Microsoft Excel software.

Holt-Winters Method: In Triple Exponential Smoothing Holt-Winters uses three parameters, namely alpha (α), beta (β), and gamma (γ). This method consists of two models, namely the Additive Holt–Winters model and the Multiplicative Holt–Winters model. This research uses Microsoft Excel software with the following stages (Akolo, 2019):

i. Determine the series pattern (Additive or multiplicative) from actual data on cocoa production (Q) and Imports (X) for 2017-2021 (Appendix 1).
ii. Determine the seasonal length (L)
iii. Determine the initial exponential smoothing (AL), trend (TL) and seasonal (St) smoothing values.
iv. Determine the alpha (α), beta (β), and gamma (γ) values where $0 \leq \alpha, \beta, \text{and } \gamma \leq 1$ based on the smallest error using the trial and error method.
v. Calculate exponential (At), trend (T¬t), and seasonal (It) smoothing values with equations (additive or multiplicative)
vi. Calculate the forecast value for the next m periods (Ft + m).
vii. Selection of the best method from the smallest RMSE or MSE value (close to zero)

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. The form of the equation is as follows:

$$Y_t = \mu + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \cdots + \theta_p Y_{t-p} - \phi_1 \varepsilon_{t-1} - \phi_2 \varepsilon_{t-2} - \cdots - \phi_q \varepsilon_{t-q} + \varepsilon_t$$

This research uses Eviews software with the following stages:

i. Identify whether the data pattern is stationary or not: Augmented Dickey-Fuller (ADF) test and correlogram from actual data on cocoa production (Q) and imports (X).
ii. Determining the best model (p,d,q) automatically with eviews
iii. Estimation of Model Parameters: t-test, F-test, coefficient of determination (R2), AiC (Akaike Information Criterion) and SC (Schwarz Criterion)
iv. Diagnostic tests: Barlett, Box, and Pierce and Ljung-Box tests.
v. If the model is appropriate, proceed to forecasting.

Best Model Selection Stage:

i. Comparing the smallest RMSE/MSE values for cocoa production and imports from the Triple Holt-Winters and ARIMA models
ii. Choose the best model based on the smallest RMSE/MSE value

Results and Discussion:

Forecasting Method Triple Holt-Winters Method:

Forecasting Cocoa Production: Several stages of analysis of actual cocoa production (Q) data from January 2017 to December 2021 using the Holt-Winters method are as follows:

i. Determine on the time series plot whether the seasonal pattern is additive or multiplicative

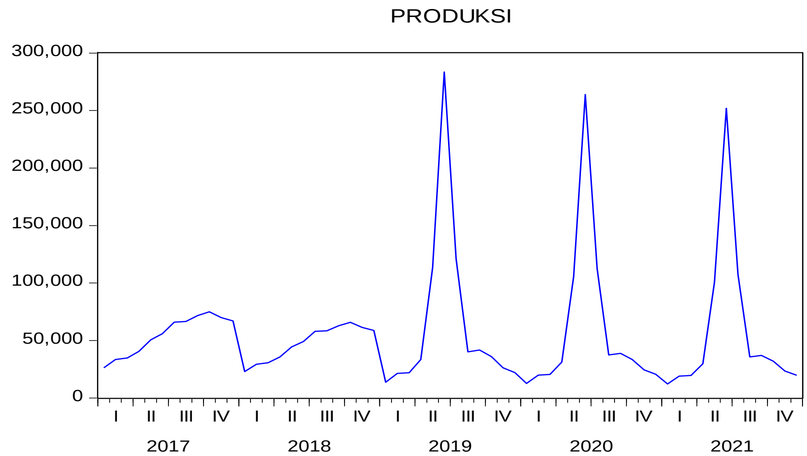


Figure 1: Plot of Cocoa Production Data in Indonesia

The image above shows that there is an increase/trend in the data, namely the distribution of the data is not around the average value, and there is a seasonal factor, namely in the form of repeated fluctuations that are the same over a certain period. It detects the presence of a multiplicative seasonal Holt-Winters exponential smoothing model on the Production data. This research uses a seasonal period (L) of 12 months (January-December).

ii. Determine the initial value of the initial exponential smoothing (AL), trend (TL) and seasonal (St) estimates.

L	$Q_{1\,(2017)}$	$Q_{2\,(2018)}$	$(Q_2 - Q_1)$	$(Q_2 - Q_1)/12$	Q_t/A_L
1	26164	22978	-3186	-265,5	0,48
2	33443	29370	-4073	-339,417	0,61
3	34820	30580	-4240	-353,333	0,64
..	…	…	…	…	…
12	66885	58740	-8145	-678,75	1,22

$$A_L = \frac{1}{L}(Q_1 + Q_2 + \cdots + Q_L)$$

$$A_L = \frac{(26164+33443+\cdots+66885)}{12} = 54754$$

$$T_L = \frac{1}{L}\left(\frac{Q_{L+1}-Q_1}{L} + \frac{Q_{L+2}-Q_2}{L} + \cdots + \frac{Q_{L+t}-Q_t}{L}\right) = \sum \frac{(Q2-Q1)/12}{12} = -556$$

$S_t = Q_t / A_L$ (multiplicative)

1. Using the trial and error method, the best-estimated parameter values $\propto = 0$, $\beta = 1$, and $\gamma = 0.98$, the smallest RMSE value is 38651.
2. Calculation of Exponential Smoothing (At), trend (T¬t), and seasonality (It)

Multiplicative Holt-Winters:

$$A_t = \alpha \frac{Q_t}{I_{t-L}} + (1-\alpha)(A_{t-1} + T_{t-1})$$

$$A_{13} = (0)\frac{22978}{0{,}48} + (1-0)(54754 - 556) = 54192, \ldots A_{60}$$

$T_t = \beta\ (A_t - A_{t-1}) + (1-\beta\ )T_{t-1}$
$T_{13} = (1)(54192 – 54754) + (1 – 1) (-556) = -552,\ldots T_{60}$

$I_t = \gamma \frac{Q_t}{A_t} + (1-\gamma\ )I_{t-L}$
$I_{13} = (0,98)\frac{22978}{54192} + (1- 0,98)\ 0,48 = 0,42,\ldots I_{60}$

1. Next, look for the forecast value for the next m periods (F_{t+m}).

$F_{t+m} = (S_t + mT_t)\ I_{t-L+m}$
$F_{60+1} = (36802 + (1)(-253)(0,31) = 11161,\ldots F_{120}$

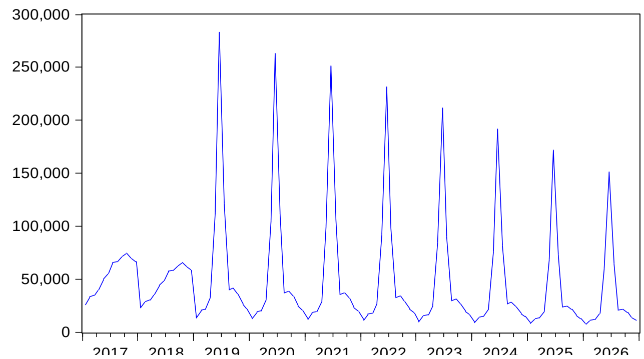


Figure 2: Graph of Cocoa Production Forecasting Results[2]

Forecasting Cocoa Imports: Several stages of analysis of actual import data (X) of cocoa for January 2017 to December 2021 using the Triple Holt-Winters method are as follows:

1. Determine on the time series plot whether the seasonal pattern is additive or multiplicative

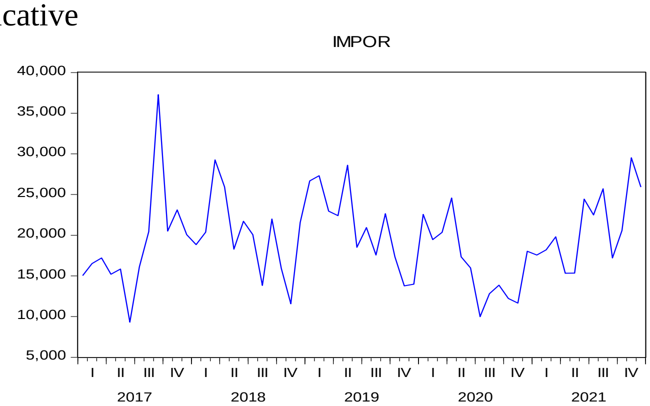


Figure 3: Plot of Cocoa Import Data in Indonesia

[2] Source: Data processed by Eviews 12

The image above shows a plot of cocoa import data in Indonesia from 2017 to 2021 showing seasonal data variations from time series data which experience increases or decreases that are not constant or fluctuations that appear to change or vary according to the Multiplicative Holt-Winters model graph. This research uses a seasonal period (L) of 12 months (January-December).

2. Determine the initial value of the initial exponential smoothing (AL), trend (TL) and seasonal (St) estimates.

$A_L = \frac{1}{L}(X_1 + X_2 + \cdots + X_L)$

$A_L = \frac{(15035+16506+\cdots+20067)}{12} = 18884$

$T_L = \frac{1}{L}\left(\frac{X_{L+1}-X_1}{L} + \frac{X_{L+2}-X_2}{L} + \cdots + \frac{X_{L+t}-X_t}{L}\right) = \sum\frac{(X2-X1)/12}{12} = 89$

$S_t = X_t / A_L$ (multiplikatif)

L	$X_{1\,(2017)}$	$X_{2\,(2018)}$	$(X_2 - X_1)$	$(X_2 - X_1)/12$	X_t / A_L
1	15035	18839	3804	317	0,80
2	16506	20373	3867	322.25	0,87
3	17196	29267	12071	1005.917	0,91
…	…	…	…	…	…
12	20067	21566	1499	124.9167	1,06

1. Using the trial and error method, one can automatically obtain the best-estimated parameter values ∝ = 0.03, β = 0, and γ = 0.68, the smallest RMSE value is 7423.

Calculation of Exponential Smoothing (At), trend (T¬t), and seasonality (It), namely:

Multiplicative Holt-Winters:

$A_t = \alpha\frac{X_t}{I_{t-L}} + (1-\alpha)(A_{t-1} + T_{t-1})$

$A_{13} = (0{,}03)\frac{18839}{0{,}80} + (1 - 0{,}03)(18884 - 89) = 19114, \ldots A_{60}$

$T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1}$

$T_{13} = (0)(19114 - 18884) + (1-0)(89) = 89, \ldots T_{60}$

$I_t = \gamma\frac{X_t}{A_t} + (1-\gamma)I_{t-L}$

$I_{13} = (0{,}68)\frac{18839}{19114} + (1 - 0{,}68)(0{,}80) = 0{,}92, \ldots I_{60}$

Next, from the three equations, the forecast value for the next m periods is obtained (F_{t+m}).

$F_{t+m} = (S_t + mT_t)\,I_{t-L+m}$

$F_{60+1} = (24125) + (1)(89)(0{,}91) = 22052, \ldots F_{120}$

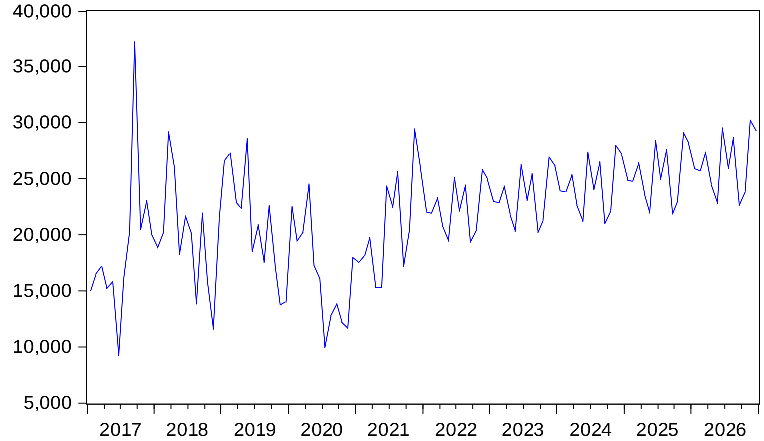


Figure 4: Graph of Cocoa Import Forecasting Results for 2017-2026[3]

ARIMA Method Forecasting:

Cocoa Production: Several stages of cocoa production data analysis for January 2017 to December 2021 using the ARIMA method are as follows:

Identify Cocoa Production Data Patterns for 2017-2021:

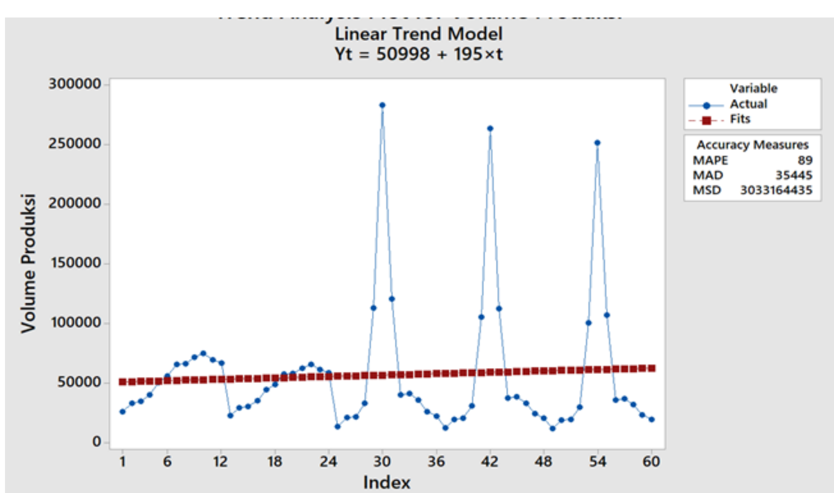


Figure 5: Plot Analysis of Cocoa Production Trends in Indonesia 2017-2021

The picture above shows that the cocoa production time series data plot has a relationship trend that tends to be slightly upward, but the upward trend is not very significant and the fluctuations in production data are around the average where the cocoa production time series data has a constant average value but is carried out further identification.

First, identify stationary data using the Augmented Dickey-Fuller (ADF) test.

[3] Source: Data processed by Eviews 12

Table 1: Augmented Dickey-Fuller (ADF) Test on Cocoa Production

	t-statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.401763	0.0000

In the table above, the Prob value is obtained. ADF Cocoa Production = 0.0000 < 0.05, then reject H0 that the data does not have a unit root, meaning the data is stationary at level level. Second, identify the ACF and PACF patterns (partial autocorrelation function) through a correlogram with level 0 data differentiation.

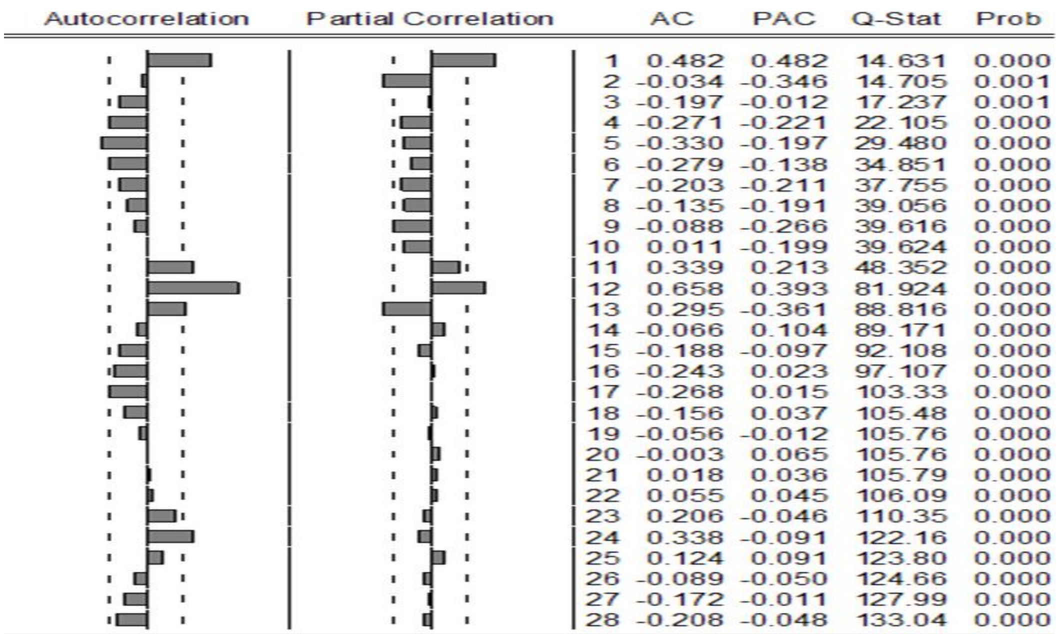


Figure 6: Cocoa Production Correlogram Graph 2017-2021

The picture above shows that the PAC value exceeds the threshold line at lag-2, so the AR order = 2, while the AC value exceeds the threshold line at lag-1, so the MA order = 1. There is seasonality in the data, this can be seen from lag-12 and The lag-12 PAC return exceeds the limit value, so it can be considered that the SAR = 1 and SMA = 1 values.

Model Parameter Estimation: Using Eviews, data processing was carried out using the equation d = 0, p = 1, q = 1, SAR = 1, SMA = 2, c = 12. The results obtained were as follows:

Table 2: Selection Criteria for the Best ARIMA Model for Cocoa Production

No.	Model	AIC
1.	ARIMA $(1,0,1)(1,0,0)^{12}$	0,474
2.	ARIMA $(1,0,1)(1,0,1)^{12}$	0,507
3.	ARIMA $(0,0,1)(1,0,0)^{12}$	0,590
4.	ARIMA $(0,0,1)(1,0,1)^{12}$	0,621
5.	ARIMA $(1,0,0)(1,0,2)^{12}$	0,683

The table above shows that ARIMA (1, 0, 1)(1,0,0)12 is the best model compared to other models because it has the smallest AIC value.

Diagnostic test/model evaluation: Diagnostic test stages in the ARIMA model (1, 0, 1) (1, 0, 0)12 with residual analysis via ACF and PACF correlograms.

Date: 01/12/24 Time: 06:41
Sample (adjusted): 2018M02 2021M12
Q-statistic probabilities adjusted for 3 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.004	0.004	0.0009	
		2	-0.018	-0.018	0.0175	
		3	-0.082	-0.082	0.3717	
		4	-0.075	-0.075	0.6712	0.413
		5	-0.108	-0.113	1.3143	0.518
		6	-0.131	-0.146	2.2841	0.516
		7	0.022	-0.001	2.3123	0.679
		8	-0.029	-0.065	2.3609	0.797
		9	-0.005	-0.051	2.3625	0.884
		10	-0.018	-0.059	2.3832	0.936
		11	-0.010	-0.058	2.3902	0.967
		12	-0.006	-0.046	2.3928	0.984
		13	-0.012	-0.041	2.4025	0.992
		14	-0.015	-0.057	2.4178	0.996
		15	-0.012	-0.048	2.4278	0.998
		16	-0.013	-0.055	2.4412	0.999
		17	0.009	-0.030	2.4474	1.000
		18	-0.004	-0.043	2.4488	1.000
		19	-0.001	-0.042	2.4489	1.000
		20	-0.002	-0.041	2.4491	1.000

Figure 7: ARIMA Cocoa Production Diagnosis Residual Graph (1,0,1)(1,0,0)12

In the picture above, the p-value for the ARIMA cocoa production model (1,0,1)(1,0,0)12 is obtained at all lags greater than 0.05, so H0 is accepted, meaning the residual contains white noise. It can be concluded that ARIMA (1,0,1)(1,0,0)12 is the best model.

Forecasting/prediction: After processing the data with Eviews, the RMSE value obtained from the ARIMA model (0,0,1)(0,0,2)12 is 3781 and the forecasting results for cocoa imports in Indonesia for 2022-2026 are shown in the following graph:

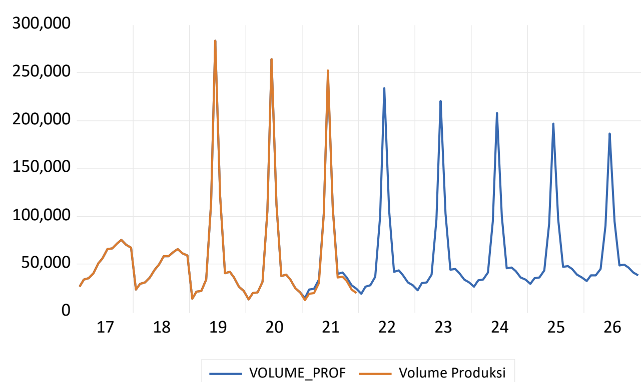


Figure 8: Graph of ARIMA Cocoa Production Forecasting Results (1, 0, 1) (1, 0, 0)12 [4]

[4] Source: Data processed by Eviews 12

Cocoa Imports:

Identify Cocoa Import Data Patterns for 2017-2021: Several stages of analyzing cocoa import data from January 2017 to December 2021 (Appendix 1) using the ARIMA method are as follows:

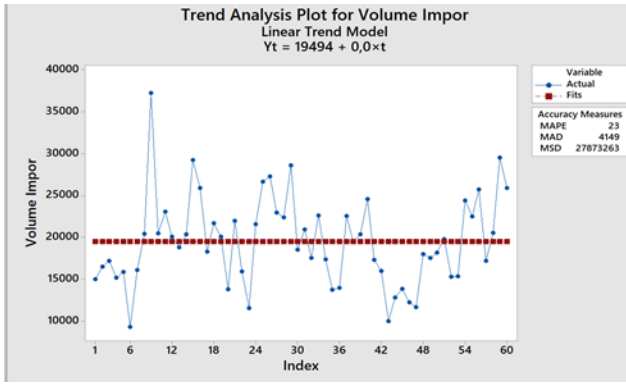


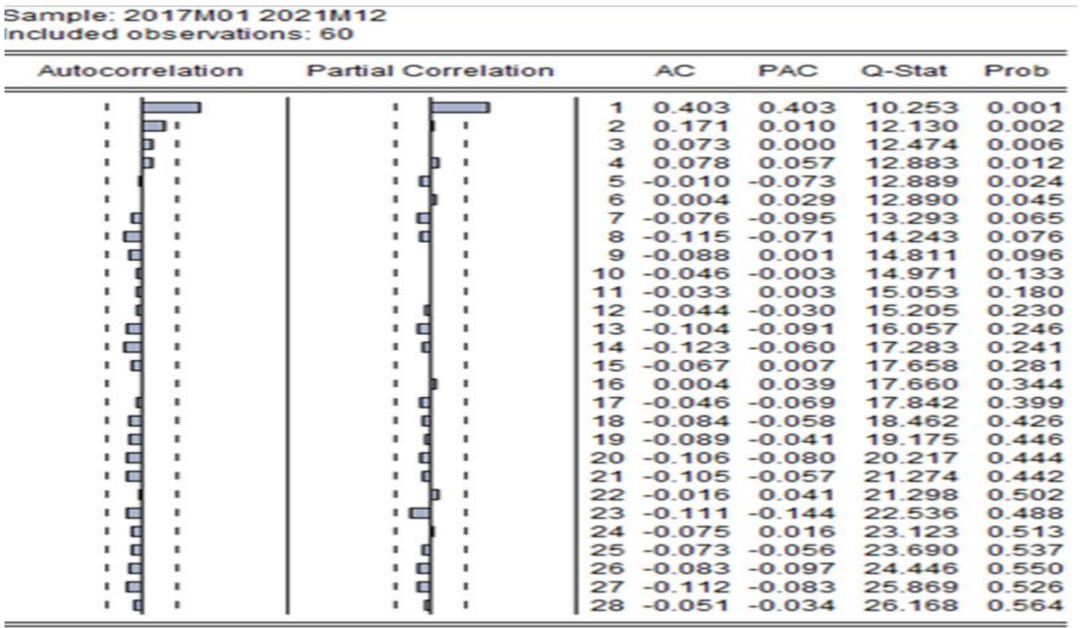
Figure 9: Cocoa Import Trend Analysis Plot

The data plot shows that the cocoa import trend analysis plot in Indonesia for 2017-2021 has fluctuated from time to time. Overall, the data plot does not show a significant trend, meaning that the data is stable or constant and does not change over some time.
First, identify data stationarity identified by the Augmented Dickey-Fuller (ADF) test.

Table 3: Augmented Dickey-Fuller (ADF) Test on Cocoa Imports

	t-statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.821637	0.0002

In the table above, the Prob value is obtained. ADF Imported Cocoa = 0.0002 < 0.05, then rejecting H0 means the data does not have a unit root, meaning the data is stationary at the 95% level. Second, identify ACF and PACF patterns (partial autocorrelation function) through a correlogram with level 0 data differentiation.


Sample: 2017M01 2021M12
Included observations: 60

Lag	AC	PAC	Q-Stat	Prob
1	0.403	0.403	10.253	0.001
2	0.171	0.010	12.130	0.002
3	0.073	0.000	12.474	0.006
4	0.078	0.057	12.883	0.012
5	-0.010	-0.073	12.889	0.024
6	0.004	0.029	12.890	0.045
7	-0.076	-0.095	13.293	0.065
8	-0.115	-0.071	14.243	0.076
9	-0.088	0.001	14.811	0.096
10	-0.046	-0.003	14.971	0.133
11	-0.033	0.003	15.053	0.180
12	-0.044	-0.030	15.205	0.230
13	-0.104	-0.091	16.057	0.246
14	-0.123	-0.060	17.283	0.241
15	-0.067	0.007	17.658	0.281
16	0.004	0.039	17.660	0.344
17	-0.046	-0.069	17.842	0.399
18	-0.084	-0.058	18.462	0.426
19	-0.089	-0.041	19.175	0.446
20	-0.106	-0.080	20.217	0.444
21	-0.105	-0.057	21.274	0.442
22	-0.016	0.041	21.298	0.502
23	-0.111	-0.144	22.536	0.488
24	-0.075	0.016	23.123	0.513
25	-0.073	-0.056	23.690	0.537
26	-0.083	-0.097	24.446	0.550
27	-0.112	-0.083	25.869	0.526
28	-0.051	-0.034	26.168	0.564

Figure 10: Cocoa Import Correlogram Graph

The picture above shows that the PAC value exceeds the threshold line at lag-1, so the AR order = 1. Furthermore, because the AC value exceeds the threshold line at lag-1, the MA order = 1. It is because, from the correlogram graph, there are no lags that exceed the threshold line. after the previous lag, there is no seasonality in the data so the SAR value = 0 and SMA = 0.

Model Parameter Estimation: Using Eviews, data processing was carried out using the equation d = 0, p = 1, q = 1, SAR = 0, SMA = 0, c = 12. The results obtained were as follows:

Table 4: Selection Criteria for the Best ARIMA Model for Cocoa Imports

No.	Model	AIC
1	ARIMA (1,0,0)	0,118
2	ARIMA (1,0,1)	0,151
3	ARIMA (0,0,1)	0,161
4	ARIMA (0,0,0)	0,312

The table above shows that ARIMA (1,0,0) is the best model compared to other models because it has the smallest AIC value

Diagnostic test/model evaluation: Diagnostic test stages in the ARIMA model (1,0,0) with residual analysis via ACF and PACF correlograms.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.015	-0.015	0.0139	
		2	0.019	0.019	0.0378	0.846
		3	-0.029	-0.029	0.0922	0.955
		4	0.064	0.063	0.3623	0.948
		5	-0.075	-0.073	0.7392	0.946
		6	0.053	0.049	0.9296	0.968
		7	-0.031	-0.025	0.9981	0.986
		8	-0.029	-0.039	1.0558	0.994
		9	-0.073	-0.061	1.4386	0.994
		10	0.008	-0.006	1.4429	0.998
		11	-0.005	0.006	1.4445	0.999
		12	0.001	-0.005	1.4445	1.000
		13	-0.056	-0.051	1.6879	1.000
		14	-0.067	-0.077	2.0486	1.000
		15	-0.037	-0.033	2.1615	1.000
		16	0.045	0.040	2.3341	1.000
		17	-0.022	-0.023	2.3747	1.000
		18	-0.069	-0.078	2.7908	1.000
		19	-0.056	-0.060	3.0778	1.000
		20	-0.047	-0.056	3.2821	1.000
		21	-0.096	-0.100	4.1517	1.000
		22	0.065	0.048	4.5670	1.000
		23	-0.099	-0.118	5.5434	1.000
		24	0.016	0.005	5.5688	1.000

Figure 11: ARIMA Cocoa Import Residual Diagnosis Chart(1, 0, 0)

In Figure 11, the p-value for the ARIMA(1,0,0) model at all lags is > 0.05, so H0 is accepted, meaning the residual contains white noise. It can be concluded that ARIMA(1,0,0) is the best model.

Forecasting/prediction: After processing the data with Eviews, the RMSE value obtained from the ARIMA(1,0,0) model was 4563 and the forecasting results for cocoa imports in Indonesia for 2022-2026 are shown in the following table:

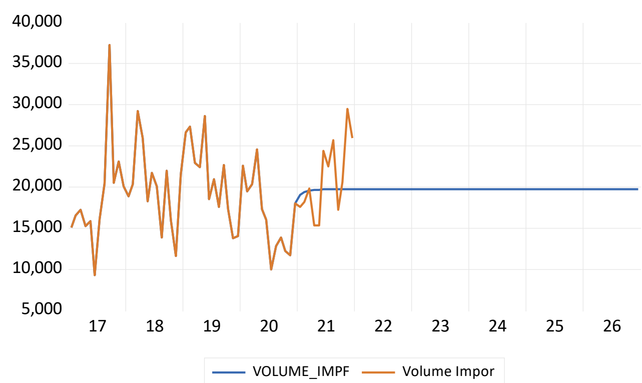


Figure 12: 2017-2026 Cocoa Import Graph ARIMA (1,0,0) [5]

Selection of the Best Method for Production and Cocoa Forecasting Results:

[5] Source: Data processed by Eviews 12

i. The best forecasting method for cocoa production in 2022-2026 in Indonesia is the ARIMA method (1,0,1)(1,0,0)12 which gets an RMSE value of 3781 which is the smallest compared to the Triple Holt-Winters method which gets a value RMSE of 38651.

ii. The best forecasting method for cocoa imports in 2022-2026 in Indonesia is the ARIMA (1,0,0) method which gets an RMSE value of 4563 which is the smallest compared to the Triple Holt-Winters method which gets an RMSE value of 7432.10

Description of Forecasting Results for Cocoa Production and Imports in Indonesia:

1. The results of forecasting cocoa production for 2021-2026 show an increasing trend with an average of 1.4 per cent from 2021 of 688,208 tons to 747,949 tons in 2026. It can be concluded that several cocoa production and productivity development program policies influence cocoa growth which will increase from 2022 to 2026.

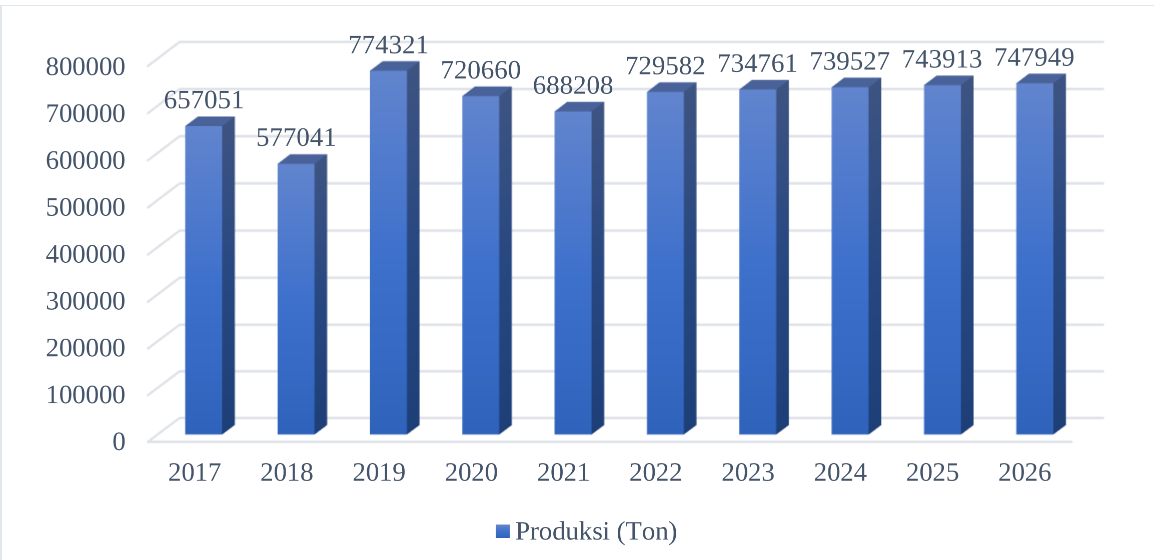


Figure 13: Results of Cocoa Production Forecasting for 2017-2026 in Indonesia

2. The results of forecasting cocoa imports for 2021-2026, that in 2021 it was 252122 tonnes, decreasing in 2022 to 235225 tonnes then increasing in 2023 to 236408 tonnes until the import volume moved constantly until 2026. Overall, the trend in the forecasting results of cocoa imports 2022-2026 will move constantly so that the implementation of several cocoa sustainability program policies can reduce cocoa imports and absorb a lot of domestic cocoa production.

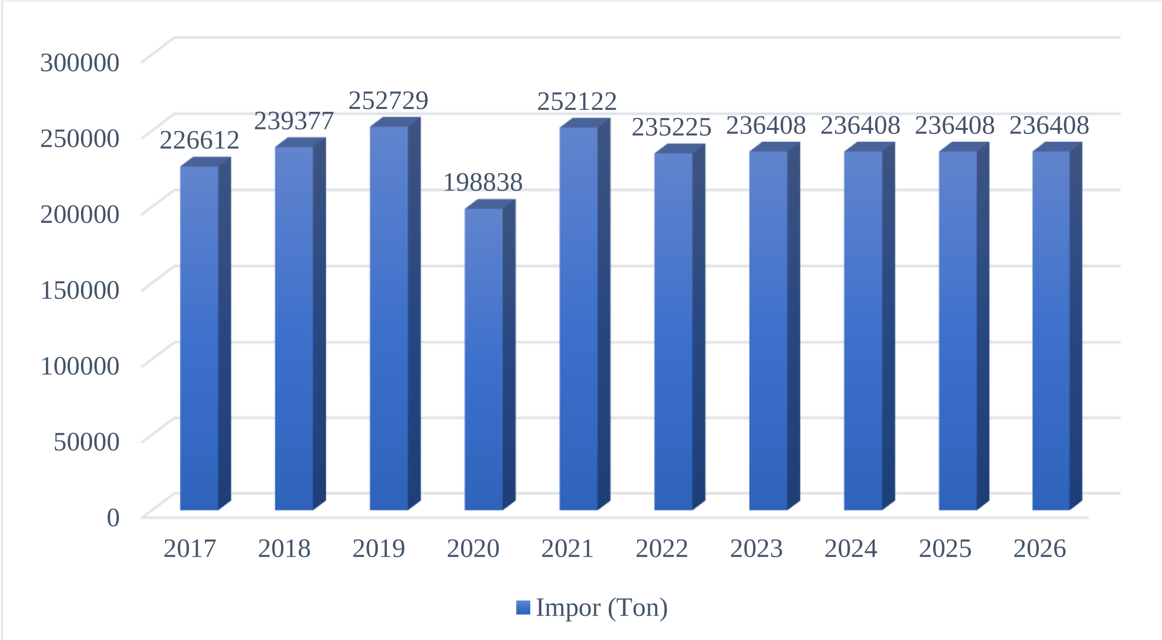


Figure 14: Results of Cocoa Production Forecasting for 2017-2026 in Indonesia

Conclusion:

Based on the research results, it can be concluded that the best forecasting method for cocoa production in 2017-2021 is the ARIMA method (1,0,1)(1,0,0)12 which gets an RMSE value of 3781 and the best forecasting method for cocoa imports in 2017-2021. 2021, namely the ARIMA (1,0,0) method which gets an RMSE value of 4563. The results of forecasting cocoa production for 2022-2026 experience an increasing trend, while the results of forecasting cocoa imports for 2022-2026 do not change (constant) so the implementation of several sustainability program policies Cocoa influences the development of cocoa in Indonesia.

APPENDIX 1

Actual Data on Cocoa Production (Q) and Imports (X) in January 2017 to December 2021

No.	Year	Month	Production (Q)	Import (X)
1	2017	January	26164	15035
2	2017	February	33443	16506
3	2017	March	34820	17196
4	2017	April	40525	15205
5	2017	May	50557	15849
6	2017	June	55869	9309
7	2017	July	65902	16116
8	2017	August	66492	20438
9	2017	September	71607	37269
10	2017	October	74951	20516
11	2017	November	69836	23106
12	2017	December	66885	20067
13	2018	January	22978	18839
14	2018	February	29370	20373
15	2018	March	30580	29267
16	2018	April	35590	25939
17	2018	May	44401	18294
18	2018	June	49066	21711
19	2018	July	57877	20071
20	2018	August	58395	13822
21	2018	September	62888	21992
22	2018	October	65824	15927
23	2018	November	61332	11576
24	2018	December	58740	21566
25	2019	January	13639	26676
26	2019	February	21263	27307
27	2019	March	21987	22963
28	2019	April	33495	22401
29	2019	May	113423	28604
30	2019	June	283485	18504
31	2019	July	120931	20942
32	2019	August	40148	17566
33	2019	September	41657	22651
34	2019	October	35918	17353
35	2019	November	26276	13772
36	2019	December	22099	13990
37	2020	January	12694	22562
38	2020	February	19789	19462
39	2020	March	20463	20350
40	2020	April	31174	24570
41	2020	May	105563	17346
42	2020	June	263839	15983
43	2020	July	112550	9980
44	2020	August	37366	12818
45	2020	September	38770	13861
46	2020	October	33429	12218

No.	Year	Month	Production (Q)	Import (X)
47	2020	November	24455	11662
48	2020	December	20568	18026
49	2021	January	12122	17571
50	2021	February	18898	18210
51	2021	March	19542	19808
52	2021	April	29770	15324
53	2021	May	100809	15338
54	2021	June	251959	24441
55	2021	July	107482	22492
56	2021	August	35683	25718
57	2021	September	37024	17202
58	2021	October	31924	20574
59	2021	November	23354	29517
60	2021	December	19641	25927

References

Abdoellah, S. (2021). Analisis Kinerja dan Prospek KOMODITAS KAKAO. *Jurnal Analisis dan Opini Perkebunan*, *2*.

Akolo, I. R. (2019). Perbandingan exponential smoothing holt-winters dan arima pada peramalan produksi padi di provinsi gorontalo. *Jurnal Technopreneur (JTech)*, *7*(1), 20-26.

Badan Pusat Statistik (2021) *Statistik Kakao Indonesia 2017-2021*, Badan Pusat Statistik Indonesia, Jakarta.

FAOSTAT. (2022). Crops and livestock products: cocoa. *FAO United Nations*. https://www.fao.org/faostat/en/#data/QCL.

Firdaus, M. (2018). *Aplikasi Ekonometrika untuk Data Panel dan Time Series*. Bogor: PT. Penerbit IPB Press.

Handayani, T. (2020). *Peramalan Tingkat Produksi Kakao Tahun 2021 Di Provinsi Sumatera Utara Dengan Metode Double Exponential Smoothing Brown* (Doctoral dissertation, Universitas Islam Negeri Sumatera Utara).

Hasibuan, H. L. (2023). Perbandingan Peramalan Time Series Musiman Menggunakan Pemulusan Eksponensial *Holt-Winters* dan SARIMA (Kasus Studi:Data Ekspor Sumatera Barat), *BAREKENG: Journal of Mathematics and Its Applications, 17*(3), 1773-1784.

ICCO. (2021). ICCO Statistic, Côte d'Ivoire, Diakses. https://www.icco.org/statistics/.

Jatim Newsroom (2020) Kakao Indonesia Diminati Pasar Ekspor, Jawa Timur, Agustus. https://kominfo.jatimprov.go.id/read/umum/kakao-indonesia-diminati-pasar-ekspor

Karim, I., Fatmawaty, D., A. & Wulandari, E. (2020). *Agribisnis Kakao*. CV Budi Utama, Sleman.

Lubis, A., & Nuryanti, S. (2011). Analisis Dampak ACFTA dan Kebijakan Perdagangan Kakao di Pasar Domestik dan China. *Jurnal Kebijakan Pertanian, 9*(2), 143-156.

Makridakis, S. W. (1999). *Metode dan Aplikasi Peramalan edisi ke-2*, Erlangga, Jakarta.

Mulyono, D. (2017) Harmonisasi Kebijakan Hulu-Hilir dalam Pengembangan Budidaya dan Industri Pengolahan Kakao Nasional. *Jurnal Ekonomi & Kebijakan Publik, 7*(2), 185–200.

Rahman, D., Sumarjaya, I. W., & Sukarsa, I. K. G. (2018). Perbandingan Peramalan Hasil Produksi Ikan Menggunakan Metode Permulusan Eksponensial Holt-Winters Dan Arima. *E-Jurnal Matematika*, *7*(4), 371.