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The Prospects of Lampung's Pepper Export to the Global Market: An Analysis Using the ARIMA Model

Najah Hanifah Putri, Zainal Abidin*, Suriaty Situmorang

Department of Agribusiness, Faculty of Agriculture, Universitas Lampung, Prof. Dr. Ir. Sumantri Brojonegoro Road, Lampung (35141), Indonesia

*Corresponding author e-mail: zainal.abidin@fp.unila.ac.id

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ABSTRACT

Pepper is one of Lampung's leading export commodities. It can be seen from the contribution of Lampung Province's pepper, which accounted for 42 percent of Indonesia's overall pepper exports. However, pepper production and export volume in Lampung Province continue to decline annually. This study aims to analyze the prospect of Lampung's pepper export to the international market for ten years, from 2023 - 2033. This research used ARIMA (Auto Regressive Moving Average) t model tool using E-views statistical software to forecast the trend of export of Lampung pepper to the International market. The data used was secondary data from the quarterly export of Lampung's pepper from 2002 to 2022. The study suggested that Lampung's pepper exports are projected to decrease from 2023 to 2033, with a decrease of 10 percent each year. Finally, in 2033, Lampung's pepper exports to the international market only reached 998 tons.

Keywords: ARIMA; export; forecasting; pepper; time series

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1. Introduction

Trade is an important economic activity, and all countries participate in such activities, whether it is trade between regions or countries (Purnamawati, 2002). In the agricultural sector, the most significant contributor to exports came from the planting subsector, with a contribution of 94 percent. Pepper is one of the products of the plantation sub-sector, which is traded on the international market as Indonesia's leading commodity product. Plant exports in January – November 2021 reached Rp 569.11 trillion, experiencing an increase of 42.47 percent compared to the same period in 2020 (BPS, 2021). The trade contribution of pepper to GDP in 2021 will be one of the largest among other crops, amounting to USD 145 million, or 0.012 percent of the total GDP *(Direktorat Jendral Perkebunan*, 2021).

Indonesia has two types of pepper, black pepper or Lampung Black pepper, which comes from Lampung, and white pepper or Munthok White Pepper, which comes from Bangka Belitung. Pepper is widely used as a cooking spice and body warmer and for use in the industrial sector, such as food, pharmaceuticals, and cosmetics. The ability to export pepper in a country can be associated with an increase in land area and production of pepper. However, during 2017–2021, pepper production in Lampung Province declined. In addition, the production of pepper in Lampung province is relatively stable despite a decrease in 2021, so by 2021, the productivity of the pepper is calculated to be low, which is 0.32 tons per hectare, while the potential production standard is 2.5 tons per hectare (Kemala, 2011).

Table 1. Distribution of land, production, and export of pepper in Lampung province, 2017 – 2021

Year	Land area (Ha)	Production (Ton)	Productivity (Ton/Ha)	Export volumes (Ton)
2017	45,776	15,064	0,33	14,853
2018	45,883	14,451	0,31	12,279

Table 1. (*continued*)

Year	Land area (Ha)	Production (Ton)	Productivity (Ton/Ha)	Export volumes (Ton)
2019	45,848	14,732	0,32	14,663
2020	45,813	14,718	0,32	24,993
2021	46,847	14,698	0,31	15,567
Average growth	0,58	-0,58	0,85	8,7

Source : *Direktorat Jenderal Perkebunan*, 2022

Table 3 shows that during the last ten years (2017 – 2021), the land area development in Lampung has increased with an average growth of 0.58 percent. However, the production of Lampung pepper decreased with an average growth of 0.58 percent. The decrease in pepper production will affect the volume of Lampung pepper exports, which experienced a rather significant decline in 2021, which reached 37.5 percent in a year. Meanwhile, pepper production experienced a significant increase in other major exporting countries in the same period, such as Brazil, with an average growth of 21.5 percent per year (FAO, 2021). Lampung Province certainly has much potential, one of which is pepper, a leading commodity. However, pepper exports continue to decline every year. The decline in pepper exports was caused by production problems, which could decrease the world's pepper market share (Mahdi, 2021).

According to the Ministry of Industry and Trade (DISPERINDAG) of Lampung province, in 2021, recorded exports of black pepper reached 15.567 tons or a value of 59.685.574 U.S. dollars (USD) or Rp 851.415.000.000 (assuming the dollar exchange rate of Rp 14.265). The volume of pepper exports from Lampung province during the period 2016–2021 has fluctuated but tends to decrease in 2021, which reaches 37 percent when compared to 2020. A comparison of the volume of exports of Indonesian and Lampung black pepper in 2021 shows that the contribution of Lampung pepper exports in 2021 amounted to 43.32 percent of the total export of Indonesia's pepper.

According to IPC (2017), price fluctuations have been a significant concern that has influenced the marketing and production of pepper over the last few decades. Indonesia's pepper market depends on the export market for pepper, which results in pepper prices tending to fluctuate. The price received by farmers significantly influences farmers' decisions to produce pepper. When the price is high, it will be an incentive for farmers to increase their output so that the share of pepper exports can be increased and make the position of the pepper Province of Lampung as a producer and exporter of world pepper increase (Kium, 2014).

The research problem in this study is the prospect of exporting pepper from Lampung province to the international market. This study aims to discover the pepper export from Lampung province to the international market for the next ten years. This research is expected to provide benefits for the government as a source of information in formulating policies that can be useful for developing the competitive pepper trade of Lampung province in the international market. For readers, as reference material and consideration in carrying out evaluation and planning related to the export of pepper from Lampung province to the international market. In addition, for other researchers, as a comparison or literatus study for comparative studies.

2. Theoretical Underpinning

A country needs to promote the comparative advantages of its goods and services to compete in international trade. According to the comparative advantage principle, a commodity must be produced with comparatively higher productivity and/or lower costs. It establishes the terms of trade, the relative pre-trade price in each nation, and the advantages that can be gained for its trading partners (Nugroho & Prasada, 2020).

ARIMA completely ignores the independent variable in forecasting. ARIMA uses past and present values of dependent variables to produce accurate short-term forecasts. ARIMA is suitable for using observations from statistical time series related to one another (dependent). ARIMA can also be combined using an artificial neural network to get more cohesive results and better validity (Abidin *et al.*, 2022).

Nagwani (2015) analyzed time series data using the ARIMA model to predict per capita income as a tool for policymaking and planning for the future of a country. One of the differences between the ARIMA

method compared to other methods, ARIMA does not provide conditions for a data pattern so that it can be used for all types of data patterns. Goyal *et al.* (2021) analyzes the agricultural export trend and forecast in India. The Autoregressive Integrated Moving Average (ARIMA) model developed by Box and Jenkins in 1976 is used in this study. This technique analyses its trend and predicts the next cycle using historical data from univariate time series. The advantage of the ARIMA method is that the prediction results are outstanding in the short term (Salwa *et al.*, 2018).

Agbo (2023) analyzes price volatility for agricultural products, especially export commodities in Egypt, namely green beans, tomatoes, onions, oranges, grapes, and strawberries, respectively, depending on the ARIMA model, GARCH model, and EGARCH model Hanan. The government's policy on international trade states that the factors that affect exports can be seen from the demand and supply sides (Arsyad, 2015). Mejaya *et al*. (2016) states that the relationship between production and export volume is positive. It is because when the amount of production increases, the number of offers in the country and abroad will increase. In Ridha *et al*. (2019), the results showed that the export volume of Indonesian pepper still fluctuated, indicating that the global Indonesian pepper market was unstable.

One is caused by a decrease in pepper production from pepper production centers. A significant increase has not matched the demand for pepper in the world in the volume of exports of Indonesian pepper, and even exports have tended to fluctuate. According to Brahmana & Novianti, (2022) research, one of the obstacles to pepper exports is low quality due to contamination by microorganisms due to the traditional production system of Indonesian farmers.

3. Research Methods

The research method used in this research is the descriptive research method. Descriptive research is conducted to determine the value of independent variables, either one variable or more (independent), without comparing or connecting with other variables (Sugiyono, 2018). According to Sudjana (2016), descriptive research seeks to describe a symptom, event, or event that is happening at present, while the quantitative approach uses numbers, starting from data collection, interpretation of the data, and the appearance of the results.

This research covers the export of landfill products from Lampung province to the international market. The data used for this research was secondary data about the volume export of pepper of annual and quarterly exports of land from Lampung province collected from related institutions within the scope of the Ministry of Agriculture, such as the Lampung Provincial Farming Department and institutions outside the Ministry of Agriculture, such as the Central Statistics Authority of the Provincial Lampung and Farming Statistics. The data period used was for 14 years, that is, from 2002 – 2022. The type of pepper used for this research was with the code Harmonized System pepper 090411 (pepper of the genus Piper, neither crushed nor ground).

Forecasting is an activity carried out to estimate future events based on past data so that it can anticipate conditions that will occur in the future (Saputra *et al*., 2022). The data processing method used in this research was the ARIMA method with the help of statistical software, namely Eviews. The method used consisted of three stages. The first stage was the identification of data patterns, especially the results of autocorrelation and partial autocorrelation. This phase aims to determine whether the initial data is needed to differentiate. Data should be differentiated when values on ACF and PACF indicate non-differentiation.

The second stage was to conduct an estimate and diagnostic process by looking at the results of the estimation and diagnosis to determine whether the estimate of the temporary model that has been determined has conformity or not. If the model has a match, then the model can be used to make predictions. If the model still needs to be matched, then it is necessary to re-identify the ACF and PACF values.

The last step was prediction (forecasting). This step was to make predictions after obtaining the best model from the estimate and diagnostic stages. The forecast was made by entering the annual, quarterly export volume data of the Lampung Province for 2002–2022 and then predicted using the equations obtained from the diagnostic process.

3.1. Autoregressive Model (AR Model)

The Autoregressive (AR) model is a model that assumes that data in the current period is influenced by data in the previous period (Fitriani *et. al*., 2002). The Autoregressive model predicts Yt as a function

of past data, namely t-1, t-2,...., t-n. The Auto Regression (AR) term (p) and the Moving Average (MA) term (q) can be used to define the model parameters for ARIMA (p, d, and q). ARIMA models are created by combining these two model components using the differencing term (d or I) (ArunKumar *et al.*, 2022). The AR model is commonly known as the order p abbreviated AR (p) or ARIMA (p,0,0) and has the following formula (Santoso, 2009)

$$Yt = A_0 + A_1\, Y_{t-1} + A_2\, Y_{t-2} + \ + A_P\, Y_{t-p} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Description:
Y_t = predicted AR values are future values that are result from function of lag time series values
Y_{t-1}, Y_{t-2}, Y_{t-p} = lag time series value are values of previous years noted in index of t-p
A_0 = constant
A_1, A_2, A_P = coefficients each variables of the model
e_t = error

3.2. Moving Average (MA Model)

Moving Average is a forecasting method by collecting a group of observed values and then looking for the average value to predict the next period (Siswanto & Eka, 2021). Moving Average is a forecasting method that involves taking a group of observation values and looking for the average value as a forecast for the coming period (Subagyo, 2008). The MA model is a statistical time series model with data characteristics in the current period having a linear combination of white noise in the previous period with a specific value (Santoso, 2009).

$$Yt = W_1\, e_{t-1} - W_2\, e_{t-2} - \ldots - W_q\, e_{t-q} + et \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Description:
Y_t = predicted MA values
W_1, W_2, W_q- = coefficient
e_t, e_{t-2}, e_{t-q} = value of white noise
e_t = error

3.3. Autoregressive Integrated Moving Average Model (ARIMA Model)

We can work with traditional statistical models to model time series, including moving average, exponential, smoothing, and ARIMA. These models are linear since the future values are assumed to be linear functions of past data (Fattah *et al.*, 2018). The ARIMA model is a model that uses the assumption that the time series data used has static data (Santoso, 2009). The ARIMA model is proposed by Box-Jenkins, where the ARIMA model results from a combination of autoregressive and moving average methods (Chandra *et al*., 2002).

The accuracy of forecasts is the primary measure used to evaluate the ARIMA model's effectiveness. It is determined using the forecast error of the model. The observed data has been separated into two subsets: a training set for parameter estimation and a test set for forecast accuracy verification (Ospina *et al.,* 2023). ARIMA has four main steps in creating models: identification, Estimation, diagnosis, and Forecast. The first four steps of this tentative model are identified by ACF and PACF charts. Determine and find out the possible model; the next step involves validating the model and using simple statistics and confidence intervals to determine (Bandyopadhyay, 2016).

The ARIMA model is formed based on 3, an autoregressive component with the order $p \neq 0$ and $q = 0$, integrated, which has order determined based on the number of pros differencing is done, and the moving average has order $q \neq 0$ and $p = 0$. If order $p \neq 0$ and $q \neq 0$, then it is called the ARMA(p,q) model (Lailiyah & Manuharawati, 2018). ARIMA is very good for long-term forecasting short, while long-term forecasting accuracy is not good. Usually, it will tend to be flat (horizontal/constant) for quite a long period (Haslina *et al*., 2018).

The Autoregressive Integrated Moving Average (ARIMA) model is popular for forecasting univariate time series datasets. This method consists of four main stages: identification, parameter assessment, diagnostic examination, and forecasting using the ARIMA model (p, d, q) (Hariadi & Sulantari, 2021). ARIMA forecasting equation for stationary time series is a linear equation like a regression in which

the predictors are composed of the dependent variable lag and the estimated lag error. Thus, the general form of the ARIMA equation can be seen in the following equation (Wei, 2006). (Dritsaki *et al.*, 2021)

$$(1-\phi 1B-\ldots-\phi_p B_p)(1-B)dZ_t=(1-\theta 1B-\ldots-\theta_q B_q)at \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Description:
Zt = Time series data
P = Orde *Autoregressive*
d = Orde *Differencing*
q = Orde Moving Average
ϕp = Autoregressive coefficient of order highest p
θq = The moving average coefficient of order highest q
B = Operator backshift
d = Highest order differencing process
at = Time series process error

4. Results and discussion

The prospects of pepper Province Lampung's future trade exports might be known through predictive analysis (forecasting). The data used was the volume export data of Lampung province for 2002 – 2022. Figure 1 depicts the results of the graph of data time series volume of exports from Lampung province in the global market from 2002 to 2022.

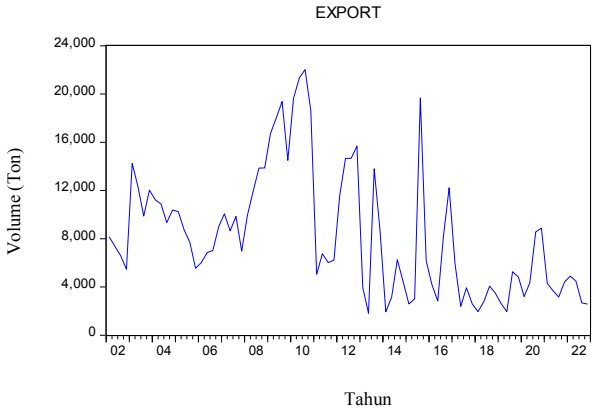


Figure 1. Graph test of Lampung Province pepper export volume in the international market for the period 2002 – 2022

Based on the graph test results shown in Figure 1, it can be seen that the export volume of pepper from Lampung Province in 2002 was 27,598 tons. Then, in 2022, the export volume of Lampung Province pepper will drop drastically to 14,639 thousand tons with an export value of US$ 47 million. The highest pepper export volume in Lampung Province was 31,441 tons in 2015.

Based on Figure 1, the results of the graph test on Lampung pepper export volume data to the international market in 2002 – 2022 experienced fluctuations and showed that the data was not stationary. Static data should display graphs with straight or constant lines. Therefore, it is necessary to identify the data again by conducting a root test at the level so that output is produced in tabular form, as seen in Table 2.

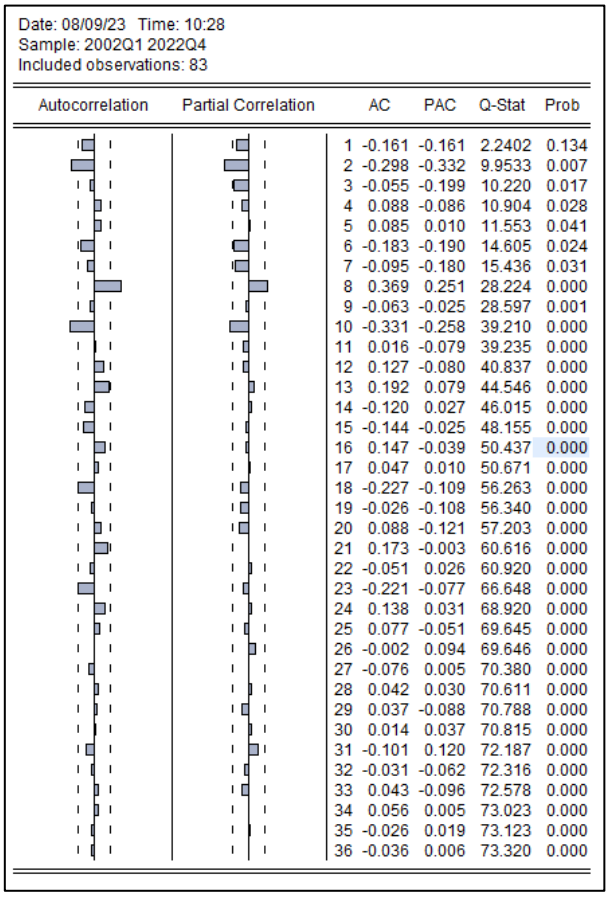
Table 2. Unit root test data on the export volume of Lampung province pepper in the international market

Levels	Results of ADF	Test *critical values* 5%	Prob.
Level	-3,88303	-2,89677	0,0033
1st difference	-9,51334	-2,89767	0,0000

In Table 2 for level levels, the data has shown datasets because it shows a 0,0000 probability value that has a slower value than 0.05 and has a cryptic value at the α=5% level of -2.89767 that is greater than the Augmented Dickey-Fuller Test Statistic (ADF) or its statistical t value of -9.51334. Since the data on the level has been stationary, there is no need to differentiate at the level 1st difference.

The test unit root tests at the level showed that the data volume export of pepper in Lampung province in 2002 – 2022 has had a data caste because it meets the rule that the probability value is less than 0.05. The ADF value is already more significant than the value α = 5% (Deka *et al*., 2019). Data on the volume of pepper exports from Lampung province in 2009-2022 can now be said to be stationary at this level. The result of this root unit test yields a value d on ARIMA (p,d,q) of 0. Once the value of d is obtained, the following values of p and q will be sought. To obtain p and q values can be seen from the identification of ACF and PACF using correlogram tests.

Identify the best ARIMA model by looking at the bars on the ACF and PACF columns as well as the results of the correlogram test (Adebayo et al., 2014). If the bar correlogram test results in the ACF and PACF columns show an equation, then the ARMA model is appropriate for the prediction (Zhou *et al*., 2006). Correlogram test results are presented in Figure 2.



	AC	PAC	Q-Stat	Prob
1	-0.161	-0.161	2.2402	0.134
2	-0.298	-0.332	9.9533	0.007
3	-0.055	-0.199	10.220	0.017
4	0.088	-0.086	10.904	0.028
5	0.085	0.010	11.553	0.041
6	-0.183	-0.190	14.605	0.024
7	-0.095	-0.180	15.436	0.031
8	0.369	0.251	28.224	0.000
9	-0.063	-0.025	28.597	0.001
10	-0.331	-0.258	39.210	0.000
11	0.016	-0.079	39.235	0.000
12	0.127	-0.080	40.837	0.000
13	0.192	0.079	44.546	0.000
14	-0.120	0.027	46.015	0.000
15	-0.144	-0.025	48.155	0.000
16	0.147	-0.039	50.437	0.000
17	0.047	0.010	50.671	0.000
18	-0.227	-0.109	56.263	0.000
19	-0.026	-0.108	56.340	0.000
20	0.088	-0.121	57.203	0.000
21	0.173	-0.003	60.616	0.000
22	-0.051	0.026	60.920	0.000
23	-0.221	-0.077	66.648	0.000
24	0.138	0.031	68.920	0.000
25	0.077	-0.051	69.645	0.000
26	-0.002	0.094	69.646	0.000
27	-0.076	0.005	70.380	0.000
28	0.042	0.030	70.611	0.000
29	0.037	-0.088	70.788	0.000
30	0.014	0.037	70.815	0.000
31	-0.101	0.120	72.187	0.000
32	-0.031	-0.062	72.316	0.000
33	0.043	-0.096	72.578	0.000
34	0.056	0.005	73.023	0.000
35	-0.026	0.019	73.123	0.000
36	-0.036	0.006	73.320	0.000

Figure 2. Correlogram test results

Based on Figure 2, the correlogram test results indicate that the ARIMA model is used because there are similarities between the ACF and PACF values. Judging from the results of the ACF and PACF bars, it can be predicted that the possible models are ARIMA (1,1,1), ARIMA (1,1,2), ARIMA (2,1,1), and ARIMA (2,1,2) because there is a cutoff in the third lag. The possibility of a predetermined model is called a tentative model because the best forecasting model is still unknown (Farooqi, 2014).

Based on tentative experimental models, the best model can be sought by looking at values from the Akaike info criterion (AIC), Schwarz Info Criterion (SIC), and adjusted R-square. The best model will show a significant value on the adjusted R square and a small value on its AIC and SIC (Deka, A., & Resatoglu, 2019). The values of the AIC, BIC, and Adjusted R square on each tentative model can be read in Table 3.

Table 3. Results of AIC, BIC, and Adjusted R square values on tentative models

Model ARIMA	Adj.R square	AIC	SIC
(1,1,1)	0,170971	19,42192	19,53849
(1,1,2)	0,135939	19,43148	19,54805
(2,1,1)	0,458488	19,37810	19,54873
(2,1,2)	0,191811	19,70352	19,87414

Table 3 shows that the ARIMA model (1,1,1) may be best suited for predictive use. The adjusted R square value of the ARIMA model (1,1,1) is the most significant compared to other models. Therefore, the ARIMA model (1,1,1) is the next model and can be formulated into equations to predict the volume of pepper exports from Lampung province.

$$(1\text{-}0{,}603779\ B)\ (1 - B)\ Zt = (1\text{-}1{,}0000000\ B) - at \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (4)$$

The forecast was made to estimate the volume of pepper exports of Lampung province to the international market for the next ten years. In this forecast, the data to be predicted is the volume of pepper exports from Lampung province to the international market from 2023 until 2033. The results of the forecast volume of Lampung province in the international market can be seen in Table 4.

Table 4. Results of the forecast of the volume of pepper exports of Lampung Province in 2023-2032

Year	Forecast (Ton)
2023	13,872
2024	14,285
2025	13,031
2026	11,556
2027	10,051
2028	8,543
2029	7,034
2030	5,525
2031	4,016
2032	2,507
2033	998

Based on Table 4, the results of the forecast analysis of the volume of pepper exports in Lampung province will experience an increase in 2024 and a decline in the next nine years. In 2025-2033, the volume of pepper exports of Lampung Province is expected to continue to decrease, with annual export growth reaching minus 10 percent. By 2033, Province Lampung's export volume will reach 998 tons. The results of the forecast data of the volume of pepper exports from Lampung province in the period 2023 – 2033 can be seen in Figure 3.

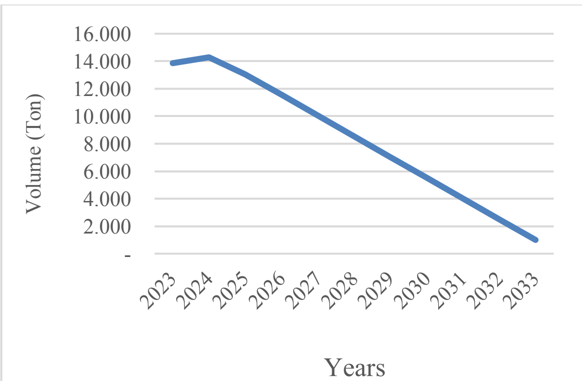


Figure 3. Graphic forecast of the volume of pepper exports of Lampung province in 2023 – 2032

The continuous decline in the volume of pepper exports in Lampung province is due to the world's pepper supply being much more extensive when compared to its consumption. According to the Ministry of Commerce (2019), the world's pepper production since 2002 has increased by an average of 7 to 8 percent per year, while its pepper consumption has only grown by 2 percent per year. In addition, the

quality of Vietnamese pepper is also better than Lampung province pepper. The Vietnamese government helps farmers and businessmen maintain the production and export of their land through government policy (Ariesha *et al*., 2019). Despite having superior quality, Vietnam has also constantly improved the quality of pepper through cooperation agreements with the American Spice Trade Association (ASTA) and the European Spice Association (ESA) to provide the science to pepper farmers so that they can solve technical problems that can decrease its quality.

In order to improve the quality of Indonesian pepper so that it can compete with other producing countries, the government of Indonesia has formulated a policy on post-harvest pepper handling guidelines through the Regulation of the Minister of Agriculture No. 55/permentan/OT.140/9/2012. The policy is structured to preserve or even improve the quality of pepper seeds, minimize the loss of the pepper harvest, facilitate the transportation of products, improve the efficiency of processing processes after harvesting, increase the added value of the harvest yield, and increase pepper competitiveness. In addition, the government of Indonesia has other programs to improve the quality and productivity of Indonesian pepper: revitalization, rehabilitation, extension, and intensification (Arzila, 2019).

5. Conclusion

The results of the forecast analysis show that the volume of pepper exports from Lampung province in the next ten years has a less favorable prospect because of its declining volume due to decreasing production each year. Therefore, the government should be able to carry out policy planning that has an orientation toward the welfare of farmers by providing adequate infrastructure, improving the competitiveness of the mill Province of Lampung, and giving rewards to farmers who get quality mill production results so that Lampung's position in the international market as one of the world's mill producers is much stronger.

Credit Authorship Contribution Statement: Najah Hanifah Putri: Writing original draft, **Zainal Abidin**: Perfecting Concept, Validation, Proof reading, and **Suriaty Situmorang**: supervision

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