Prospects for Increasing Production and Supply Chain of Cayenne Pepper in Indonesia

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Abstract. Chili is a horticultural commodity that has made significant contributions and has significant economic value in Indonesia. The prospect of increasing cayenne pepper production in Indonesia using simple linear regression analysis with chili production data from 1990-2022 has increased quite significantly. The attributes and results are added together to obtain the supply chain performance value based on performance attributes. These values are classified into standard performance values. The supply chain performance value based on attributes is 93.26 out of 100%. This value is obtained by adding up the values of each performance attribute. This value indicates that the performance of the Cayenne pepper supply chain in Indonesia is in the Good criteria (Above Average) based on the classification of standard work values. The SPSS output has an adjusted determination coefficient (Adjusted R Square) of 0.393. This means that 39.3% of the dependent variable (production (Y) is influenced by exports (X^1) and imports (X^2), while the remaining 60.7% (100% - 39.3) is influenced by other variables outside the variables used.

Keywords: chilli; export; performance; standard work

INTRODUCTION

Indonesia is a country that has a wealth of natural resources and very high biodiversity, the agricultural sector plays a vital role in overall economic development. So that the wealth owned must be utilized and appropriately preserved by the community. The agricultural sector comprises food crops and horticulture, plantations, animal husbandry, fisheries and forestry. Horticulture is a sector in agriculture with various types of commodities and is a sector that society needs directly. Cayenne pepper is a commodity that has high economic value in Indonesia. Cayenne pepper is a commodity that grows both in the highlands and lowlands. Cayenne pepper has quite high economic and strategic value because it can influence inflation in Indonesia (Multazam et al., 2023). This plant cannot withstand rain because the flowers fall off easily, and other damage is also caused by the quite extreme climate (Lino, 2016).

Chile is a horticultural commodity that has an important economic contribution and value in Indonesia. Chile is also a national favorite horticultural commodity. Fresh cayenne peppers have a water content of

approximately 83% so farmers don't want to take risks by storing chilies for too long because they are easily damaged. (Kusumiyati et al., 2021). The need for chilies will continue to increase because they are widely used as a cooking spice, especially on big holidays, as medicinal ingredients and so on. This results in the demand for chilies also increasing (Kurniawan et al., 2021). The amount of demand for chilies also depends on the type of chili. The demand for red cayenne pepper is relatively high compared to the demand for red chilies (Mardiana et al., 2017).

With many processing industries using cayenne pepper, the demand for cayenne pepper is increasing. This increase in demand causes the price of chilies to fluctuate so that the industry continues to grow and becomes an income opportunity (Zahara, 2021). The existence of a supply chain approach to cayenne pepper commodities is expected to provide an overview of the availability of cayenne pepper supplies as a consideration for cayenne pepper supply chain management for consumers and the processing industry (Purnama et al., 2021). The food supply chain is a complex network of agricultural and processing facilities, distributors, and

shops/retailers that covers the entire agricultural chain (Gurrala, 2022). The recent increase in food miles provides a clear picture of the globalization of the food chain and the challenges associated with increased food trade between countries (Gurrala & Hariga, 2022).

The increase in the price of cayenne pepper occurs every week. The increase is driven by the small supply of cayenne pepper on the market caused by several things ranging from weather to the distribution process. Unpredictable weather factors can have implications for the uncertainty of the amount of production which will affect the supply of cayenne pepper, causing the selling price to be uncertain and generally following the market system. Not to mention recent events such as the COVID-19 pandemic and the Ukrainian crisis have brought consequences of supply chain disruptions into our daily lives and have negatively impacted humanitarian programs in many parts of the world (Stumpf *et al*., 2023). In addition, transportation delays or prolonged rain also make the cayenne pepper rotting process faster (Indriani *et al*., 2019). Fluctuations in cayenne pepper prices are caused by inefficient management arrangements in the 3 supply chains. Efficient supply chain management can be achieved if the management and supervision of distribution channel relationships are carried out cooperatively by all parties involved. Based on the explanation above, this study was conducted to bridge the knowledge gap by revealing the influence of production, exports and imports on the prospects and supply chain of cayenne pepper in Indonesia. The results of this study are expected to be useful for policymakers and decision-makers in supporting sustainable cayenne pepper production and supply chains in Indonesia.

METHODS

This research covers the prospects for increasing the production and supply chain of cayenne pepper in Indonesia in general. The data that will be used in this research is secondary data taken from related agencies. This research will begin in September 2023.

The type of data used in this research is Secondary Data obtained from the Data Collection Institute of the Ministry of Agriculture, Central Statistics Agency (BPS), and one of the data used in this research comes from FAOSTAT (Food and Agricultural Organization of the United States). Nation). Secondary data sources are from reports or documents and through intermediary or indirect media, in the form of existing evidence books or archives, both published and not generally published.

Data Processing Methods

The data that has been processed will be analyzed using two methods, namely qualitative analysis and quantitative analysis which are used to describe the conditions of cayenne pepper production in Indonesia and explain the contents of the analysis itself. The method that can be used is simple linear regression analysis with tools to analyze it.

The descriptive method can be interpreted as a problem-solving procedure that is investigated by describing the condition of a subject or object in research, which can be a person, institution, society, etc., which is currently based on facts that are visible or that are currently occurring. they. It can be said that descriptive analysis is an analysis that attempts to describe a symptom or event, which is happening at the moment or an actual problem.

Data analysis methods

The data analysis method is a method used to process research results in order to obtain a conclusion. By looking at the theoretical framework, the technical data analysis used in this research is quantitative analysis using simple linear regression analysis tools and qualitative descriptive analysis. This research aims to determine cayenne pepper's prospects and supply chain in Indonesia. Forecasting can be assumed to be an activity used to predict what will happen in the future. This activity is carried

out by mathematically and statistically paying attention to past or current strengths or information. Forecasting aims to find out, see and estimate the prospects for cayenne pepper plants in Indonesia. Forecasting can be qualitative (not in the form of numbers), or quantitative (in the form of numbers). Qualitative forecasting is difficult to obtain good results because the 23 variables are very relative. Meanwhile, in quantitative forecasting, the forecasting results are very dependent on the method used. Different methods will produce different prediction values.

The supply chain analysis used in this research uses descriptive (qualitative) methods (Gurtu, Searcy, 2015). The steps to follow in this method are as follows:
a) Data collection, problem boundaries, and variable definition and operation.
b) Explain the production, export, import and operational variables of the cayenne pepper supply chain.
c) Data processing is used to analyze, organize and obtain information from data sets on the production, export, import and supply chain of cayenne pepper.
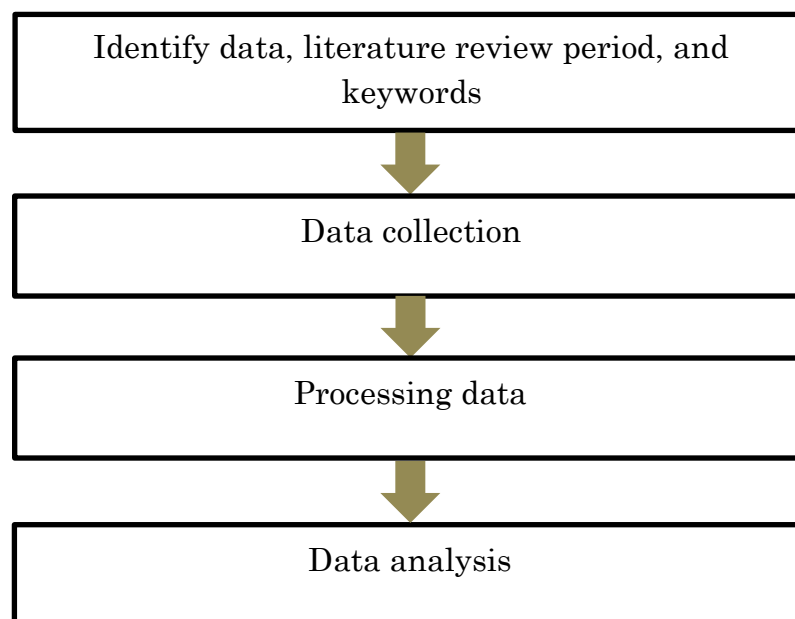d) Data analysis

Figure 1. Schematic Process Diagram (Source: Gurtu, Searcy, 2015).

At the data analysis stage (**Figure 1**), it is necessary to determine the purpose of using the cayenne pepper supply chain which is limited to 1990 to 2022. In this research, supply chain analysis aims to determine the prospects for sustainable improvement in Chili production. The next step is to collect data on cayenne pepper's production, exports, and imports. To then be integrated using each weight in the performance matrix. The next step is to add up each weight in the performance matrix.

The result of this step is the performance value of each variable.

The value of each performance is integrated with the weight of each attribute and the results are added up to obtain the performance value for the production prospects and supply chain of cayenne pepper based on the performance variables. According to (Monzcka & Handfield, 2011) implemented by (Syahputra et al., 2020) in Table 1, these values are classified based on standard performance values.

Table 1. Cayenne pepper supply chain performance standard values

Performance Value	Criteria
95 - 100	Very good
90 - 94	Good
80 – 89	At the moment
70 – 79	Not enough
60 – 69	Very less
<60	Bad

Source: Monzcka & Handfield, 2011.

$Y = \beta o\ X^1 \beta^1 X^2\ \beta^2$…….. (1)

After logging in it will be:

$\text{Log } Y = \text{Log } \beta^o + \beta^1 \log X^1 + \beta^2 \text{ Log } X^2 + ui$ …. (2)

Information :

Y	= Cayenne Pepper Production
β^o	= Constant
β^1, β^2	= Regression Coefficient
X^1	= Import of Cayenne Pepper
X^2	= Export of Cayenne Pepper
ui	= Nuisance Variable

This analysis is used to determine how much influence production, export and import levels have on the prospects and supply chain of cayenne pepper in Indonesia. This research used simple linear regression analysis methods and qualitative descriptive analysis. From these two analyses, the parameters of each independent variable will be obtained, which shows the magnitude of the influence of the independent variable on the dependent variable.

RESULTS AND DISCUSSION

This research analyzes data on production, exports, and imports of cayenne pepper commodities from 1990-2022 using qualitative and quantitative methods. This research also uses a simple linear regression model, namely a probabilistic model which states that there is a linear relationship between two variables where one variable is considered to influence the other variable. The variable that influences it is called the independent variable and the variable that influences it is called the dependent variable. This analysis is used to predict the influence of predictor variables on criterion variables or to prove whether there is a functional relationship between the independent variable (X) and the dependent variable (Y). Data on production, exports, and imports of cayenne pepper for 1990-2022 will be used to predict the standard value of supply chain performance in Indonesia using simple linear regression analysis. Data processing uses Microsoft Excel as a tool to find simple regression equations.

After collecting data on the production, export, and import of cayenne pepper in Indonesia, the Pre-Process process will then be carried out based on the data obtained. The Pre-Processing stage is carried out to convert the data obtained into a format or data suitable for further analysis or the required analysis. This stage includes data filtering by eliminating unnecessary data. The data used in this research are the year and amount of production, export and import of cayenne pepper in Indonesia. Calculates X^1, X^2, X^3, X^4, Y^1, Y^2, Y^3, Y^4, XY values from Pre-Processing data. X^1 value, this calculation is useful for calculating simple linear regression equations. FAOSTAT (2024) provides data that will be used to analyze the first problem formulation.

Supply chain performance calculations are done by finding the actual and target value in production using the selected metrics. The actual and target values were obtained by referring to data on the cayenne pepper production in 2023. **Table 2** provides a description of the calculation of performance metrics.

Table 2. Explanation of calculation of supply chain performance metrics

Performance Attributes	Performance Metrics	Explanation
Reliability	Order fulfillment	(Number of consumer requests fulfilled within the appropriate time and quantity/total consumer orders) x 100%
	Delivery quantity accuracy	(The number of orders sent corresponds to the number/total of orders sent
	Order perfect condition	(Number of orders shipped in perfect condition/total orders shipped) x 100%
Responsiveness	Order cycle time	Procurement + processing + delivery cycle time
	Packaging cycle time	The time required to package the product
	Delivery scheduling cycle time	The amount of time required to make deliveries after the product is manufactured
	Processing cycle time	The time required to process raw materials into products that are ready to be marketed
Adaptability	Top supply chain adjustments	The percentage increase in product quantity produced when there is an unexpected increase in demand which can be achieved within 30 days
	Lower supply chain adjustments	Percentage reduction in quantity of product produced if minimum demand can be achieved before 30 days
	Top supply chain flexibility	Total time required to increase production by 20%
Cost	Production labor costs	Costs paid to production workers in units of time
	Production cost	Raw material purchase costs + production labor costs + processing costs
	Shipping costs	The costs required to distribute products to consumers
Asset Management	Cash cycle time	Inventory days + average days of receivables receipts – average days of payables payments
	Length of debt repayment	The length of time required to incur necessary costs such as payment for raw materials
	Time of receipt of receivables	The length of time it takes for consumers to receive payment for products

The achievement percentage value is then integrated with the weight of each performance metric and then added up based on the performance attributes, producing a performance value for each attribute. The value of each performance is then integrated with the weight of each attribute.

The results are added up to obtain a supply chain performance value based on these attributes. According to (Monzcka & Handfield, 2011), the values are classified into standard performance values. The results of determining and weighting supply chain performance metrics using the Analytical Hierarchy Process (AHP) pair comparison method can be seen in **Figure 2**.

Based on the results of weighting performance metrics, the business process metric that has the highest weighting value of 0.98 is processing because it is responsible for changes in raw materials so it pays close attention to the processing process. The performance parameter level that has the highest weight value is with a weight value of 0.65. The quality of the product produced will determine whether the product being marketed is good or bad. Reliability is a performance attribute that has the highest weighting value, namely 0.90, because it will determine the speed, accuracy, quality, and quantity of products distributed to final consumers as well as maintaining good relations with consumers.
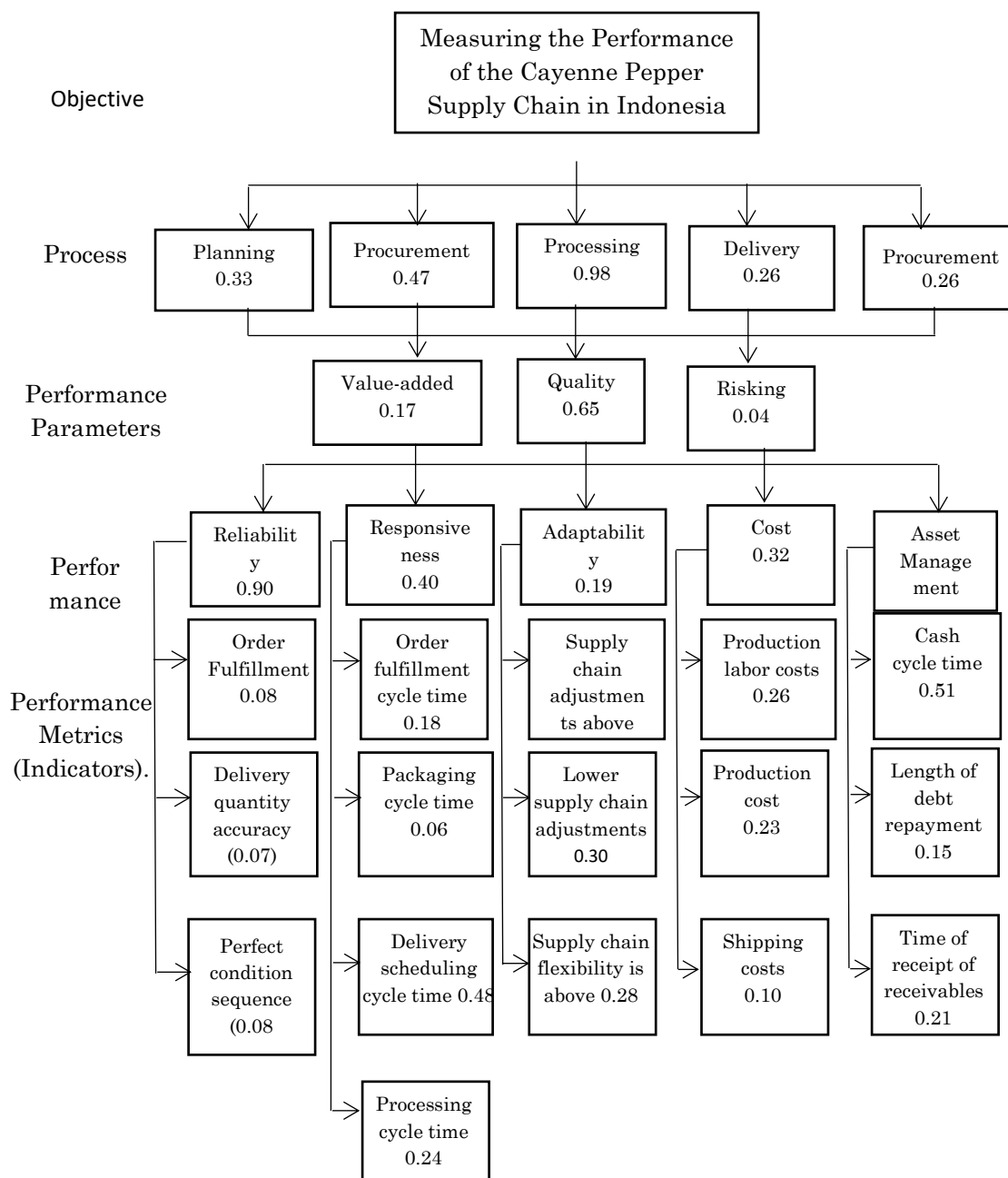
Figure 2. Results of determining and weighting performance metrics

The total value of each attribute from **Table 3** is the sum of the values of each performance metric. Then, the total attribute value will be integrated with the weight of each attribute to produce a performance value in Indonesia's cayenne pepper supply chain.

The attributes and results are added up to obtain a supply chain performance value based on performance attributes. According to (Monzcka, R.M., & Handfield, 2011), the values are classified into standard performance values. Based on **Table 4**, the supply chain performance value based on attributes is 93.26 out of 100%. This value is obtained by adding up the values of each performance attribute. This value shows that the performance of the cayenne pepper supply chain in Indonesia is in the Good criteria (Above Average) or can be seen in **Table 5** below, based on the classification of work standard values according to (Monzcka & Handfield, 2011).

Table 3. Results of measuring the performance of the cayenne pepper supply chain based on performance metrics

Performance Attributes	Performance Metrics	Unit	Heavy	Actually	Target	Bandage Relax	Value Performance Metrics	Total Performance Attribute Value
Reliability	Order fulfillment	%	0.08	97.4	100	97	7.76	
	Delivery quantity accuracy	%	0.07	100	100	100	7.00	21.96
	Order perfect condition	%	0.08	90	100	90	7.20	
Responsiveness	Order fulfillment cycle time	Day	0.18	90	100	90	16.20	
	Packaging cycle time	Minute/ Second	0.06	35	30	117	7.02	82.50
	Delivery scheduling cycle time	Day	0.48	10	15	67	32.16	
	Processing cycle time	Day	0.24	45	40	113	27.12	
Adaptability	Top supply chain adjustments	%	0.28	0.07	0.07	100	28.00	
	Lower supply chain adjustments	%	0.30	-	-	0	0.00	56.00
	Top supply chain flexibility	Day	0.28	72	72	100	28.00	
Cost	Total production labor costs	Rupiah/ Month	0.26	10,600,000	10,600,000	100	26.00	
	Production cost	Rupiah/ kg	0.23	250.000	250.000	100	23.00	61.20
	Shipping costs	Rupiah	0.10	3,668	3,000	122	12.20	
Asset Management	Cash cycle time	Day	0.51	80	90	89	45.39	
	Length of debt repayment	Day	0.15	14	14	100	15.00	79.08
	Time of receipt of receivables	Day	0.21	80	90	89	18.69	

Classical Assumptions

Based on the results of testing all classical deviations, the research data can be explained as follows:
1. Normality Test

This normality test aims to test whether, in the regression model, the dependent variable and the independent variable are both normally distributed or not. A good regression model is data that is normal or close to normal. Detect normality by looking

at the distribution of data (points) on the diagonal axis of the graph. The basis for decision-making:

- If the data is spread around the diagonal line and follows the direction of the diagonal line, then

the regression model meets the normality assumption.
- If the data is spread far from the diagonal line and does not follow the direction of the diagonal line, then the regression model does not meet the normality assumption.

Table 4. Cayenne pepper supply chain performance value based on performance attributes

Performance Attributes	Total performance attribute value	Performance attribute weights	Performance value (%)
Reliability	21.96	0.90	19.76
Responsiveness	82.50	0.40	33.00
Adaptability	56.00	0.19	10.64
Cost	61.20	0.32	19.58
Asset Management	79.08	0.13	10.28
Total			**93.26**

Table 5. Performance standard value

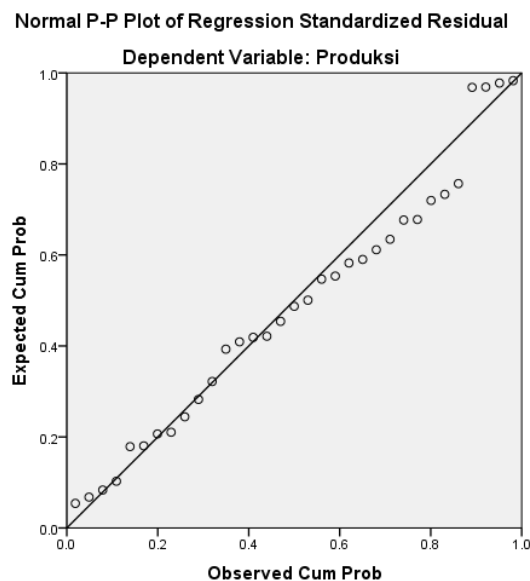| Performance Value	Criteria
95 – 100	Very Good (Excellent)
90 – 94	Good (Above Average)
80 – 89	Medium (Average)
70 – 79	Poor (Below Average)
60 – 69	Very bad
<60	Bad (Unacceptable)

Source : (Monzcka, R.M., & Handfield, 2011)

Figure 3. Normal Probability Plot Between Export Variables (X^1), Imports (X^2), and Production Variables (Y)

Based on the Normal PP Plot graph (**Figure 3**), it can be seen that the points are spread around the diagonal line, and the distribution follows the direction of the

diagonal line. This means that the data used meets the normality assumption, so the regression model is suitable for use in determining the effect of production based on the input of independent variables.

2. Heteroscedasticity Test

To test whether there is a constant variance inequality between the residuals of one observation and another observation in a regression model, it is called homoscedasticity. If the variance is different, then it is called heteroscedasticity. The heteroscedasticity test can be done by observing the remaining scatter plot.
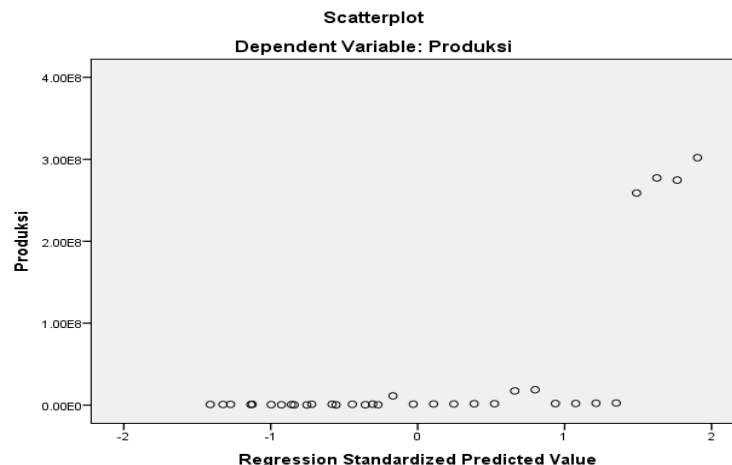

Figure 4. Heteroscedasticity Deviation Test Between Export Variables (X^1), Import (X^2) and Production (Y)

Based on the graph above, it can be concluded that the points are evenly distributed (**Figure 4**). This means that there is no heteroscedasticity in the regression model, so the regression model is suitable for use in determining the effect of production based on independent variable input.

The general equation of the influence of exports and imports on production can be made as follows:

$$Y = 36975653.332 + -5094114.560X^1 + 6755282.379X^2 \ \ldots\ldots. (3)$$

From the equation above it can be concluded that:

If all independent variables are considered constant, then the production value (Y) is 36975653.332.

If there is an increase in exports by one unit, Production (Y) increases by -5094114.560.

If there is an increase in imports by one unit, production (Y) increases by 6755282.379.

It can be seen that export (X^1) is the variable that has the greatest influence on production (Y), because of the calculated t value > t table, while the import variable (X^2) has no influence on production (Y) because of the calculated t value > t table.

2. Coefficient of determination (R2)

The SPSS output has an adjusted determination coefficient (Adjusted R Square) of 0.393. This means that 39.3% of the dependent variable (production (Y)) is influenced by exports (X^1) and imports (X^2), while other variables outside the variables used influence the remaining 60.7% (100% - 39.3). The R Square results are in line with the results (Yurivani & Kumar, 2022) because the smaller the value of the coefficient of determination, it shows that the information that can be explained by the independent variable to explain the dependent variable is very limited. variables. variables. In research (Suhendri *et al*., 2019) also obtained a lower R Square result, namely 0.160 or (16%), this shows that the percentage of the influence of the

independent variables (Current Ratio and ROA) on the dependent variable (Stock Price) is 16%, while the remaining 84% is influenced or explained by other variables that are not included in the research model. Research (Muriyatmoko, 2020) is also similar to this study, where the R Square obtained is 0.182, which means that the magnitude of the influence of the independent variable (citation) on the dependent variable (DOAJ indexation) is 18.2% while other factors influence the remaining 81.8%.

Yunita & Hajati (2019) also found the same analysis where the R Square value was 0.351 or 35.1%, but for regression it is better to use the Adjusted R Square value obtained of 0.304 (always smaller than the R Square value) to interpret the magnitude of the influence of the independent variable (X) simultaneously with the dependent variable (Y) is included in the fairly strong category.

A study by Santoso (2015), shows that the factors that affect rice production in his research are the area of rice fields, the realization of subsidized urea fertilizer, and the realization of subsidized ZA fertilizer. All of these factors are not elastic to rice production in both the short and long term. Research (Rivki *et al.*, 2019) shows that the factors that influence the production of the manufacturing industry in Indonesia are Labor (X^1), Number of Business Units (X^2), and Raw Materials (X^3). In the research (Sari *et al.*, 2014) Factors that affect soybean production in Indonesia are land area, local prices, seeds and fertilizers.

A study by Ifani et al. (2022) regarding dairy cattle productivity towards national cow's milk production found that the analysis results showed that individual cow's milk production per year affects national cow's milk production by 85.55, so this is one way that can be done. What the Government is doing to increase national milk production is to increase the population of female dairy cows in Indonesia.

In this study, the reason for the low R2 is because only a few independent factors

(X) were used, namely exports (X^1) and imports (X^2). (Wooldridge, 2015) stated that adding relevant independent variables that have a significant relationship with the dependent variable can increase the R2 value. This is because additional variables can explain more data variations.

The SPSS output shows a value of 0.00> 0.05, meaning it is not significant, while the calculated F is 11.343> F table 3.23, meaning it is significant. The analysis results obtained in this study show a relatively low R Square, in line with the findings of previous research by (Yurivani & Kumar, 2022). This relatively low R Square value indicates that the independent variables obtained in the model are only able to explain a small part of the variables that occur in the dependent variable. Similar findings were also obtained by (Suhendri *et al*, 2019), (Muriyatmoko, 2018) and (Yunita, 2019), where the R Square value obtained in their study was also below 0.50 (50%). This indicates that there are still other significant factors that are not included in this research model, which also affects the dependent variable. The research results (Yunita, 2019) show that the Adjusted R Square value can provide a more accurate picture of the predictive power of the model, especially when there are many independent variables in the model, in the context of this study, the Adjusted R Square obtained indicates that the influence of independent variables simultaneously on the dependent variable is included in the category quite strong.

Research (Santoso, 2015) factors that affect rice production in his research are the area of rice fields, the realization of subsidized urea fertilizer, and the realization of subsidized ZA fertilizer. All of these factors are inelastic to rice production both in the short and long term. Research (Arzia, 2019) found that factors that affect the production of the manufacturing industry in Indonesia are labor (X1), number of business units (X2), and raw materials (X^3). In Research (Sari, Aimon, & Syofyan, 2014) factors that affect soybean production in

Indonesia are land area, local prices, seeds, and fertilizers. Research (Ifani *et al*., 2022) dairy cow productivity on national cow's milk production found that the results of the analysis showed that individual cow's milk production per year affects national cow's milk production by 85.55, so one way that the Government can do to increase national milk production is by increasing the population of female dairy cows in Indonesia.

In general, the development of harvested area in Indonesia for the period 1990-2022 fluctuated but tended to increase with an average annual growth of 2.55%. The increase in harvested area was due to the price of chili which was quite promising and needed by the wider community, both for household consumption and the food industry. The development of chili harvested area in the last ten years (2013-2022) has increased with an average growth of 3.51%, a significant increase occurred in 2017 of 19.19% or reaching 310.15 thousand hectares with the largest contribution being in Java Island. amounting to 172.39 thousand tons or 22.05%. The growth rate in the last ten years, namely 2013-2022, experienced a growth of 3.51% or in Java Island the growth was 3.82% and outside Java Island it was lower at 3.17%. Thus, if we look at the contribution outside Java, it is lower than on Java, namely outside Java it is 45.25% and on Java it is 54.75%.

The results of the analysis of the prospects for increasing cayenne pepper production in Indonesia using simple linear regression analysis with chili production data from 1990-2022 experienced a significant increase. It is known that the highest cayenne pepper production occurred in 2022 (year 33) which was 302,026.2 tons. The results of the import analysis using import data from 1990-2022 experienced an increase, it is known that the highest cayenne pepper imports occurred in 2022 (year 33) which was 28,900 tons. The export analysis results using export data from 1990-2002 also increased. The highest cayenne

pepper exports occurred in 2022 (year 33) which was 21,025 tons.

The results of measuring supply chain performance on the attributes of reliability, responsiveness, adaptability, asset management. The supply chain performance value in Indonesia is 93.26. This performance value is included in the good criteria classification (Above Average). This supply chain is a series of processes carried out to achieve goals, starting from ordering raw materials to the shipping process to the end consumer. Supply chain performance assessment will provide benefits in evaluating performance and to what extent the supply chain can run effectively and efficiently. A periodically evaluated supply chain performance will support the right decision-making in handling supply chain problems, saving costs and increasing customer satisfaction.

Measuring supply chain performance aims to reduce operational process costs, increase customer satisfaction and improve reputation. Can identify and recommend parts that do not meet improvement targets. The focus of improvement can be in the form of providing process aid charts, sending process aid materials or machine maintenance. Effective performance management requires a proper measurement system, one of which is supply chain performance measurement. The operational objectives of supply chain performance measurement include monitoring and controlling, communicating objectives with specific parts of the supply chain, and making continuous improvements to create excellence.

CONCLUSION

The results of the analysis show that chili production, imports and exports in the 1990-2022 period have shown quite significant increases. The highest production, import and export figures for cayenne pepper will occur in 2022 (33rd year). The increasing population causes the demand for cayenne pepper to increase

yearly. Cayenne pepper has great potential to support food security and the country's economy. This provides an opportunity for farmers to increase production to meet increasing market needs.

Supply chain performance measurement results on the attributes of reliability, responsiveness, adaptability, and asset management. The supply chain performance value in Indonesia is 93.26. This performance value is included in the good criteria classification (Above Average). Measuring supply chain performance aims to reduce operational process costs, increase customer satisfaction and improve reputation. Effective performance management requires an appropriate measurement system, one of which is measuring supply chain performance. The operational objectives of supply chain performance measurement include monitoring and controlling, communicating objectives with specific parts of the supply chain, and making continuous improvements to create excellence.

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