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AUTOREGRESSIVE INTEGRATED MOVING AVERAGE FOR COCOA PRODUCTION IN SULAWESI ISLAND 2021-2030

Autoregressive Integrated Moving Average Untuk Produksi Kakao Di Pulau Sulawesi 2021-2030

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ABSTRACT

Agribusiness Cocoa on the island of Sulawesi is very supported by the availability of land plantations to produce production even bigger cocoa with management plant and processing seed good cocoa _ thus producing quality cocoa beans. However Thus, various problems are still just faced in the cultivation of cocoa which resulted in the decline in results production. At the moment this Indonesia's position is ranked third highest, however with problems production faced _ of course just rating this could shift to down, though riches nature and location geographical very support cultivation. Research results use the Autoregressive Integrated Moving Average (ARIMA) method, which shows that the area and cocoa production on Sulawesi Island in 2021-2030 experience fluctuation. Southeast Sulawesi is a province on the island of Sulawesi which has the highest area (445.91 ha) in 2030, however, Central Sulawesi Province occupies a position as the center production major by 2030 with a production of 151.68 tons/ha.

Keywords: *cocoa, development, production, Arima*

ABSTRAK

Agribisnis Kakao di Pulau Sulawesi sangat didukung oleh ketersediaan lahan perkebunan guna menghasilkan produksi kakao yang lebih besar lagi dengan pengelolaan pabrik dan pengolahan benih kakao yang baik sehingga menghasilkan biji kakao yang berkualitas. Namun demikian, berbagai permasalahan masih saja dihadapi dalam

budidaya kakao yang mengakibatkan penurunan hasil produksi. Saat ini posisi Indonesia berada di peringkat ketiga tertinggi, namun dengan masalah produksi yang dihadapi tentu saja rating ini bisa bergeser ke bawah, padahal kekayaan alam dan letak geografisnya sangat mendukung untuk budidaya itu. Hasil penelitian menggunakan metode Autoregressive Integrated Moving Average (ARIMA), menunjukkan bahwa luas areal dan produksi kakao di Pulau Sulawesi pada tahun 2021-2030 mengalami fluktuasi. Sulawesi Tenggara merupakan provinsi di pulau Sulawesi yang memiliki luas wilayah tertinggi (445,91 ha) pada tahun 2030, namun Provinsi Sulawesi Tengah justru menempati posisi sebagai sentra produksi utama pada tahun 2030 dengan produksi sebesar 151,68 ton/ha.

Kata kunci: kakao, pengembangan, produksi, Arima

INTRODUCTION

One of the leading commodities in Indonesia's plantation sub-sector which is quite potential and export-oriented is cocoa. Indonesia is the third largest cocoa producer in the world after Ivory Coast and Ghana (Hadinata & Marianti, 2020). The plantation sub-sector is the main support for export activities therefore plantations are included in the sub-sector that has the potential to provide the largest contribution to international trade. Research by Melania et al., 2020, shows that s subsector plantation has several superior commodities and has the potential to increase the country's foreign exchange, which is cocoa. This is supported by the available planting area in Indonesia, adequate labor, and the availability of sufficient cocoa experts so that it is not excessive if this potential can still be increased. This is in line with the government's goal to make cocoa a mainstay export commodity. largest producer and exporter of cocoa beans in the world (Bulkis et al., 2019). Cocoa is a consistent source of foreign exchange for the country which in 2006 reached US\$ 855 million, a contribution that is very important in the structure of the Indonesian economy. In addition, cocoa as a plantation sub-sector is the leading sector in employment (Arsyad et al., 2011).

Cocoa plants continue to be cultivated and developed because results production has proven ability to increase the Indonesian economy. Cocoa production growth every year is caused by a large number of product developments in almost every province (Tresliyana et al., 2015). To research cocoa beans (*Theobroma Cacao*) are an important agricultural crop that makes a major contribution to the nation's economic development and cocoa is used for beverages, sweets, cosmetics, soaps, and medicines. In addition, in line with research according to (Paelo et al., 2013) cocoa has consistently played a role as a source of foreign exchange which makes an important contribution to the structure of the Indonesian economy.

The cocoa sub-sector important role in the Indonesian economy, especially during the economic crisis. There are two important roles. Firstly, cocoa provides export income, and secondly, it provides a source of employment not only for millions of small rural farming families but also for urban families as plantation owners (Arsyad, 2007). In terms of the potential of natural resources, Indonesia has potential land for the development of cocoa cultivation, especially in the Sulawesi Island region. Research by Managanta, et al., 2019, showed that the development potency cultivation of Indonesian cocoa in particular development of cocoa on the island of Sulawesi is one of the mainstay commodities that can generate large foreign exchange and can increase farmers' income and welfare if productivity/production continues to increase.

However, Thus, each region on the island of Sulawesi has land and production potential that tends to decrease, increase or fluctuate because each area faces various obstacles or problems (Rifin et al., 2019). In the middle of various problems and obstacles. The productivity of cocoa plantations in several of Indonesia's main cocoa production centers has experienced a sharp decline. The government is trying to reduce the impact of the decline in production by spurring an increase in production in potential areas such as the main center of cocoa production, namely Sulawesi with revitalization. However, the program did not meet expectations due to various constraints, such as limited availability of planting material, limited training staff, and inadequate banking support (Damanik & Herman, 2010).

Table 1. Development of Cocoa Plantation Area and Production in Indonesia in 2011-2020

No.	Year	Area		Production	
		Area (Ha)	Average Growth (%)	Total Production (Tons)	Average Growth (%)
1	2011	1,732,641	4.97	712,231	-15.00
2	2012	1,774,463	2.41	740,513	3.97
3	2013	1,740,612	-1.91	720,862	-2.65
4	2014	1,727,437	-0.76	728,414	1.05
5	2015	1,709,284	-1.05	593,331	-18.54
6	2016	1,720,773	0.67	658,399	10.97
7	2017	1,658,421	-3.62	590,683	-10.28
8	2018	1.611.014	-2.86	767,280	29.90
9	2019	1,600,647	-0.64	783,978	2.18
10	2020	1,582,406	-1.14	739,483	-5.68

Data source: Pusdatin, 2021

Table 1. shows the development of Indonesia's cocoa area during the period 2011-2020 which has decreased by 0.39% per year. In 2011, Indonesia's cocoa area reached 1,732,641 ha, then in 2020 it decreased to 1,582,406 ha or reduced by 150,235 ha. The highest production during the 2011-2020 period

occurred in 2019 which amounted to 783,978 tons, while the lowest production is 590,683 tons in 2017 (Alim et al., 2020). Indonesia is one of the cocoa-producing countries, both in terms of area and in second place with a contribution of 15.89% and production in third place with a contribution of 14.09%. The main centers of cocoa production are in the eastern part of Indonesia, covering the provinces of South Sulawesi, Southeast Sulawesi, and Central Sulawesi

Research results Bulkis et al., 2019 stated that policies that reduce input costs and increase output values will increase the competitiveness of cocoa commodities, while policies that cause input costs to increase and output values to decrease will reduce competitiveness.

The main causes of the decline in production are the depletion of soil nutrients, the attack of the Cocoa Fruit Borer, and Vascular Streak Dieback (VSD) disease (Thifany et al., 2020). Various problems that occur, namely the decline in cultivation from various aspects can cause Indonesia with the third highest rank in world cocoa production to be displaced, even though with its natural wealth and geographical location it is very supportive of the cultivation of cocoa commodities. Fluctuations tend to occur in developing countries such as Indonesia, which is an agricultural country. In addition, the lack of community knowledge in managing the garden causes cocoa yields to decline, which in turn will have an impact on the decline in community welfare. In addition to garden management, harvest handling also needs to be considered. One of the Cocoa Cultivation Development Strategies which is a government policy program is the Cocoa Gernas program. According to research (Wonda & Tomayahu, 2016). Based on data, Indonesia's cocoa export volume in the last 10 years has a downward trend every year with an average of 4.13% per year. This of course also affects other countries to compete with each other in increasing their cocoa cultivation to be able to produce quality cocoa beans. Based on the phenomena and problems in cocoa development that have been described previously, this study aims to project the potential of cocoa on the island of Sulawesi.

RESEARCH METHOD

This research was conducted on the island of Sulawesi. The determination of the area of this research *was chosen purposively with the* consideration that Sulawesi Island is one of the production centers of Indonesian cocoa plantations which is also a source of foreign exchange for the country.

This research uses a descriptive quantitative research method with Secondary Data Analysis (ADS) approach. ADS is a method by utilizes secondary data as the main data source. Utilizing secondary data in question, namely by using appropriate statistical test techniques to obtain the desired information from the material body or mature data obtained at certain agencies or institutions (BPS, departments, or educational institutions) to be processed systematically and objectively.

The data analysis used in this study is the *Autoregressive Model Integrated Moving Average* (ARIMA method) which is also known as the Box-Jenkins time series method. ARIMA has very good accuracy for short-term forecasting, while for long-term forecasting long accuracy of fortune telling is not enough good. Usually will tend *flat* (flat/constant) for Point which enough long. The *Autoregressive Integrated Moving Average* (ARIMA) model is a model that completely ignores the independent variables in making estimates. ARIMA uses the past and present values of the dependent variable to generate a forecasting Point short which is appropriate. ARIMA in accordance if observation from line time (*timeseries*) by statistics link one same other (*depending on g*). The purpose of this model is to determine a good statistical relationship between predictor variables and historical variable scores so that forecasting can be carried out with the model. ARIMA only uses a line time (univariate) variable.

The advantage of the ARIMA method is that method has a flexible nature, which follows existing data patterns, and has a fairly high level of forecasting accuracy, it is suitable for forecasting several variables quickly because it only requires historical data to make forecasts. In addition, this method can accept all types of data models even though the first must be stationary. The ARIMA method is a time series method that has high accuracy (Sukiyono et al., 2018) the accuracy of both methods shows that forecasting using ARIMA is better than using DCA. Therefore the ARIMA method is better used for the prediction.

Preprocessing Data

The data on the area cocoa production show that the data is not stationary, it is necessary to *make a distinction* between line time which is not stationary must change Become data Stationery with To do *difference* (Mulyo & Hariyati, 2020). This meant with *differentiation* is count changes or differences in the value of observations. The value of the difference obtained is checked again whether stationary or not. The data is stationary if the probability value is < 0.05 and if the probability value is < 0.5 so that it can be continued to the second stage. Stationary assumptions are assumptions that must be met in time series modeling. The process of identifying seasonal models depends on statistical tools in the form of autocorrelation and partial autocorrelation. This research uses Eviews software.

Unit root test results ADF value (*Augmented Dickey-Fuller*) statistical test of data on the area and annual cocoa production of Sulawesi Island. Finding out whether data is stationary or not, it can be done by *the autocorrelation of values. function (ACF)* which is significant towards 0, or by the plot pattern that is around point 0 the non-stationary data can be indicated by *the Autocorrelation value function (ACF)* or by the plot pattern data that decreases gradually.

Model Parameter Estimation

Model Parameter estimation is to determine the parameter values in AR and/or MA, it becomes an ARIMA model. To get parameters with the to dabble method or *trial and error*, test several different values and choose one score to estimate or test with various models using the formula $d = \frac{\text{area}}{\text{area of production}} \times \text{ar (test value)} + \text{ma (trial value)}$ and by looking at the probability values on AR and MA which have provisions that are <0.05 . After *difference*, it means that the value of d has been found. After that, *trial and error are carried out* by choosing a model that has a probability value of <0.05 as a result of *trails and error*.

Diagnostic Check and Selection of the Best Model

After estimating and getting the estimator parameters, the temporary model can be used for forecasting, it is necessary to conduct a feasibility test on the model. This stage is called *a diagnostic check*. This test is carried out whether the model specifications are correct or not.

Then after a diagnostic check on the model is seen from the Q-statistical value > 0.05 , the model fits the data. After doing *trial and error* and producing data that has probability values of AR and MA <0.05 then the comparison is made, the model chosen is the best model with the criteria that it has the *largest Adjusted R-squared value, Total Residual Squared, Akaike Criteria Information (AIC)*, and the smallest *Schwarz Criterion (SBC)*.

DISCUSSION

Cocoa cultivation has been carried out in the past until now, but lately, the cocoa cultivation business of farmers has begun to be disrupted, cocoa production and quality have decreased and several efforts have been made to increase the quantity and quality of production. The potential of plantation products is still large, especially the processing of cocoa cultivation on the island of Sulawesi which is the highest production center, that can generate large foreign exchange and can increase farmers' income and welfare if productivity/production continues. Besides that according to research, the most effective to empower the people's economy is to develop the agribusiness sector because it is important in rural areas. Currently, the agribusiness sector can compete to seize market opportunities in the era of free trade.

Increasing the area of land will affect the increase in the amount of production. According to the research, land area is the entire land used by cocoa farmers in the production process. The factor of the number of workers affects the production of the business theoretically. The increase in the use of pesticides will affect the increase in the amount of production. The number of pesticides used is all pesticides used by cocoa farmers in the production process.

The dominance of smallholder cocoa plantations in Indonesia has implications for the emergence of various problems and obstacles in cocoa development in Indonesia, which causes the level of productivity and quality of cocoa produced to be still low. This is because most of the cocoa plantations are in the form of smallholder plantations which are still managed traditionally therefore the optimization of land use is very low (Wonda & Tomayahu, 2016)

Agricultural production is determined by the area of land. According to Nurul (2016) the wider the land used, the greater the amount of production. The nature of this land is slightly different from other production factors because the land area is fixed while the demand for land continues to increase. The area of control of agricultural land is important in the production process or agricultural business. for example in farming, control of narrow land is less efficient than larger land. The narrower the business area, the more inefficient farming is done.

Furthermore, the results of Hanum's (2018) research show that the current value of oil palm farming income for 25 years is greater than cocoa, namely: Rp. 90,477,202.42 for palm oil and Rp. 44,629,869.87 for cocoa. Conversion of cocoa land into other commodity lands such as palm oil and food crops is driven by several factors farmers convert cocoa land into rice fields, among others driven by production factors (production output), infrastructure factors such as irrigation, and economic factors (price stability), and cultivation. factor (pest attack and disease).

Table 2. Results of Forecasting Cocoa Area on Sulawesi Island

Trends in Sulawesi Island Cocoa Area (Ha)						
The year 2021-2030						
Year	Sulawesi North	Sulawesi Middle	Sulawesi South	Sulawesi Southeast	Gorontalo	West Sulawesi
2021	16.47	279.40	196.3	246.00	14.20	143.9
2022	16.65	296.90	206.4	267.99	26.49	135.27
2023	16.23	296.23	202.0	293.06	44.74	135.36
2024	15.81	303.50	199.5	315.18	58.20	130.9
2025	15.01	301.10	200.9	337.3	72.10	112.2
2026	14.82	301.20	185.6	363.62	85.70	111.2
2027	14.63	297.80	170.0	387.64	99.80	108.3
2028	14.81	295.70	153.0	419.96	114.2	107.5
2029	14.39	291.40	148.1	444.08	129.0	106.9
2030	13.97	291.50	173.2	445.91	143.4	106.4

Data Source: Processed in 2022

Table 2. as results analysis projection potency cocoa in the Sulawesi Island region shows that province Southeast Sulawesi has potency large the highest land compared with province others on the island of Sulawesi with an area of 445.91 ha in 2030. According to Managanta et al. (2019). the plantation sector is

a sector The mainstay of the Southeast Sulawesi government with the most potential plantation crops. and the most widely planted by the community is cocoa. The area of cocoa plantations continues to increase because local government policies that include cocoa as a priority crop are being promoted. In addition. the results study by Eka (2018) shows that the plantation sector is the mainstay of the Southeast Sulawesi government. and the most potential and most widely planted plantation crop by the community is cocoa. Nationally. fermented cocoa in Indonesia is only between 10-20% (Ariningsih et al., 2020)

However. the condition of the cocoa plants that are attacked by pests and weeds. as well as the condition of the increasingly aging and brittle stems make the cocoa plants no longer able to reproduce. The development of cocoa cultivation is still experiencing several obstacles. The most visible constraints are pest and disease attacks and the lack of human resources. Most cocoa farmers only get cocoa farming skills that are inherited from their predecessors and are still traditional. This is what makes local governments assist so that cocoa plants can reproduce well. It is hoped that the Regional Government. especially Kolaka Regency as a potential area in the Southeast Sulawesi region. can provide convenience for the development of the cocoa commodity agroindustry. These facilities can be in the form of intensive coachings such as entrepreneurship and counseling. In addition. it is necessary to encourage partnerships between small and medium entrepreneurs and large entrepreneurs. especially in terms of product marketing and quality development to add value to cocoa commodity production.

The rapid expansion of cocoa plantations is generally carried out by farmers. smallholder plantations dominate Indonesian cocoa plantations. Research stated that the success of area expansion and increased production has provided tangible results for increasing the Indonesian cocoa market in the world cocoa scene. Indonesia has successfully positioned itself as the world's second-largest cocoa producer after Ivory Coast and Ghana. According to Antu et al. (2020), cocoa is one of the plantation products that can contribute to increasing the country's foreign exchange, besides that cocoa has a high economic value and currently Indonesian cocoa is in the third highest rank after Ivory Coast and Ghana.

The next results study also shows that the largest cocoa bean production in 2019 came from Central Sulawesi Province at 128.15 thousand tons or around 17.44 percent of Indonesia's total production. In 2020. Central Sulawesi Province will become the largest cocoa bean producer in Indonesia with a production of around 128.62 thousand tons. or 17.85 percent of Indonesia's total production (Table 3).

The main production center in 2030 is Central Sulawesi with a production of 151.68 tons/ha. Regions in Central Sulawesi based on *forecasting* for the ARIMA method in 2021-2030 will increase. This province has a lot of potential

and a lot of emphasis on structuring the regional economy on agricultural commodities. The agricultural sector is a sector that has an important role in the economy of the Central Sulawesi region and consists of several regencies/cities that have large harvested areas and the production of cocoa commodities. produced by each region is different (Antu et al., 2020).

Table 3. The Results of Forecasting Cocoa Production on Sulawesi Island

Trends in Sulawesi Island Cocoa Production (Ha)						
The year 2021-2030						
Year	Sulawesi North	Sulawesi Middle	Sulawesi South	Sulawesi Southeast	Gorontalo	West Sulawesi
2021	6.273303	118.74	99.72757	114.9	4.40	71.3
2022	5.986348	183.38	95.34118	112.14	6.47	26.49
2023	5.797044	163.12	91.64293	117.04	4.99	44.74
2024	5.217138	191.06	87.53098	83.74	4.91	58.2
2025	7.566751	170.10	83.66775	92.94	3.93	72.1
2026	7.768051	171.24	79.65498	84.84	4.55	85.7
2027	7.940056	175.98	75.73212	115.04	4.67	99.8
2028	7.653109	188.38	71.75520	106.94	3.74	114.2
2029	7.463811	127.58	67.81078	106.84	2.84	129
2030	6.883915	151.68	63.84683	104.08	4.44	143.4

Data Source: Processed in 2022

The enhancement of production cocoa in Central Sulawesi Province is supported by several factors. is the experience of cocoa farmers in the area. this is in line with the age of the cocoa plant. The plants with an average age of 15 years. The results show that the lack of knowledge of the farming community in managing their gardens causes cocoa yields to decline and results in crop failure which will ultimately have an impact on the decline in community welfare. In addition to garden management. harvest handling also needs attention. Handling poor yields can reduce the quality of cocoa beans. The long experience of cultivating cocoa allows farmers to behave better in managing their farms. A similar thing is shown in the results of studies by Managanta et al. (2019) that the experience of farmers is closely related to the mental behavior of farmers and past experiences. According to. moderate experiences are more likely to participate in agricultural programs than experiences in high and low categories.

To increase cocoa production. farmers have various problems. including the relatively narrow scale of land ownership. scattered farm locations and not being supported by good facilities/infrastructure. fertilization that is not recommended. and limited knowledge and skills of the workforce. A similar thing is shown by the results of research by Eka (2018). that the development of cocoa cultivation is still experiencing several obstacles and problems. Barriers such as pest and disease attacks and agricultural land are narrow. For example

ownership or tenure of narrow land is less efficient than larger land. with fewer/lower human resources.

According to (Matondang, 2014). the most important problem is the attack of plant pest organisms (OPT). OPT is one of the factors causing the low production and quality of plantation crops. From various observations. the main causes of production decline are the depletion of soil nutrients. Cocoa Fruit Borer and Vascular Streak Dieback (VSD) attacks. decreased plant quality. and still optimal development of cocoa downstream products. According to (Murtiningrum & Bantacut. 2016) this can reduce production by up to 50% and reduce the quality of the cocoa produced. This causes a decrease in farmers' income which results in large losses.

In addition. the government's policy is to help manage cocoa plants so that they can bear fruit and produce well and effectively. In line with research (Juwita et al., 2017) Facilitators are important in empowering cacao farmer groups (beginners and experienced) in intensification and rehabilitation activities.

CONCLUSION AND SUGGESTION

Conclusion

Based on the results of data analysis and discussions that have been carried out. it can be concluded that the *Autoregressive Integrated Moving Average* (ARIMA) method and cocoa production on Sulawesi Island in various regions in 2030 has the potential to decrease. increase and fluctuate. The highest potential for increasing production occurs in Southeast Sulawesi Province with a total area of 445.91 ha in 2030 and the production center in 2030 is Central Sulawesi with a production of 151.68 tons/ha.

Suggestion

Based on the research results. suggestions that can be given are as follows. cocoa farmers or entrepreneurs in Indonesia. especially on the island of Sulawesi. pay more attention to controlling the quality of cocoa produced. to increase the competitiveness of Indonesian cocoa in international trade. The regional and central governments are expected to immediately develop a grand design or comprehensive policy plan for the cocoa industry. through policies that accommodate all aspects of the cocoa industry. from agriculture to processing factories and trade. Knowledge and education of farmers will encourage Indonesian cocoa farming to be better and of higher quality.

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