FORECASTING OF ANNUAL RICE PRODUCTION IN MALAYSIA USING ARIMA MODEL

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ABSTRACT

Rice is the most important food of a developing country. As the population of a country increases, surely the demand for rice is high as well. Forecasting rice production is necessary to ensure Malaysian survival is sustained. The aims of this study is to observe the trend of rice production in Malaysia in the future by using ARIMA model method from 1980 to 2018. Furthermore, this analysis predicted the rice production in Malaysia for five years ahead and simultaneously estimate the year of rice production that will reached the target. Based on the findings, it was determined that ARIMA (0,1,1) is the best model to predict rice production in Malaysia for 5 years ahead. Overall, the findings have shown that Box-Jenkin's model is possible to demonstrate and forecasting the rice production in the future. Forecasting results can be used by environmental department and local authorities for further development.

OBJECTIVES

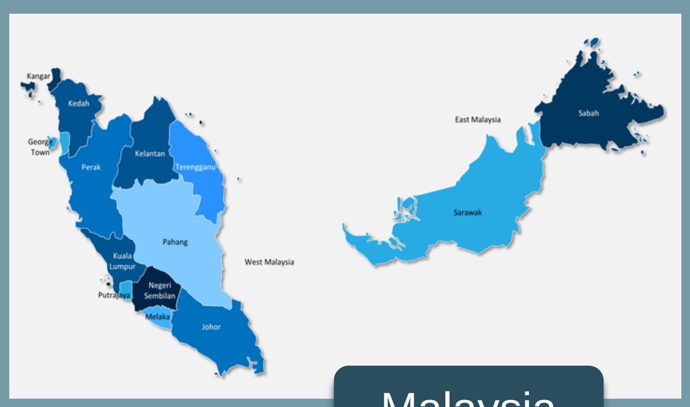
- To determine the behaviour of rice production in Malaysia
- To predict the rice production in Malaysia for five years ahead
- To estimate the forecasted value of rice production to fulfill the population demand

INTRODUCTION

Malaysia's current total population is 32.4 million with the annual population growth rate of 1.1%. Rice is a crucial part of consumption in Malaysian diet. In 2018, Malaysia has produced 1.98 million metric tonnes of rice. Despite with this high production, Malaysia only produces 80% of what it needs to support itself and on the other hand necessary external imported. The average Malaysian citizen consumes 82.3 kilograms of rice per year. The Malaysia government had targeted the production of rice will reach at 100% demand of rice. Consequently, it make more researcher invented technological advanced method to increase rice production for consumption within the nation.

METHODOLOGY

STUDY AREA & SOFTWARE USED



Malaysia

Rice

Minitab 19

BOX-JENKIN'S MODEL

STEP 1 – Initial Data Investigation

By constructing a simple time series plot and fitting a linear trend line for rice production the basic pattern of time series can be known. A cursory observation of the time series plot indicated that the data is not stationary which had increasing trend. Then, the ACF and PACF were plotted to collect more conclusive evidence on its stationary condition. The first order differencing was performed to render the original series stationary. The time series plot after undergo first order differencing one can conclude that the series is stationary.

STEP 2 – Model Identification

The second step in this analysis is to perform model identification. In order to specify the model class based on the evidence as provided by the ACF and the PACF, the close scrutiny and careful judgement of the location and size of the spikes was important to determine the number lag required. Then, the estimated model chosen necessary for validation and diagnostic test.

STEP 3 – Model Validation and Diagnostic Checking

The estimation and validation of the Box-Jenkin's model involved analyzing the residuals for resemblance of the white noise characteristic. If the residuals are white noise, then it is expected that no significant autocorrelation coefficients and no significant partial autocorrelations coefficients exist. Hence, the stationarity condition of the residuals is achieved. More sophisticated technique of establishing the stationarity condition of the residuals is to check the Ljung-Box Q statistic. This statistic is provided by the Minitab result.
The hypothesis for this statistic are:
H_0: the errors are random (white noise)
H_1: the errors are non-random (not white noise)

STEP 4 – Forecasting process

After obtaining the optimum model for each period, the next step is to prepare the forecasted sample of rice production. By using the best selected model, rice production in Malaysia from year 2019 to 2023 was successfully forecasted to fulfill the population demand on rice.

ANALYSIS RESULTS & DISCUSSIONS

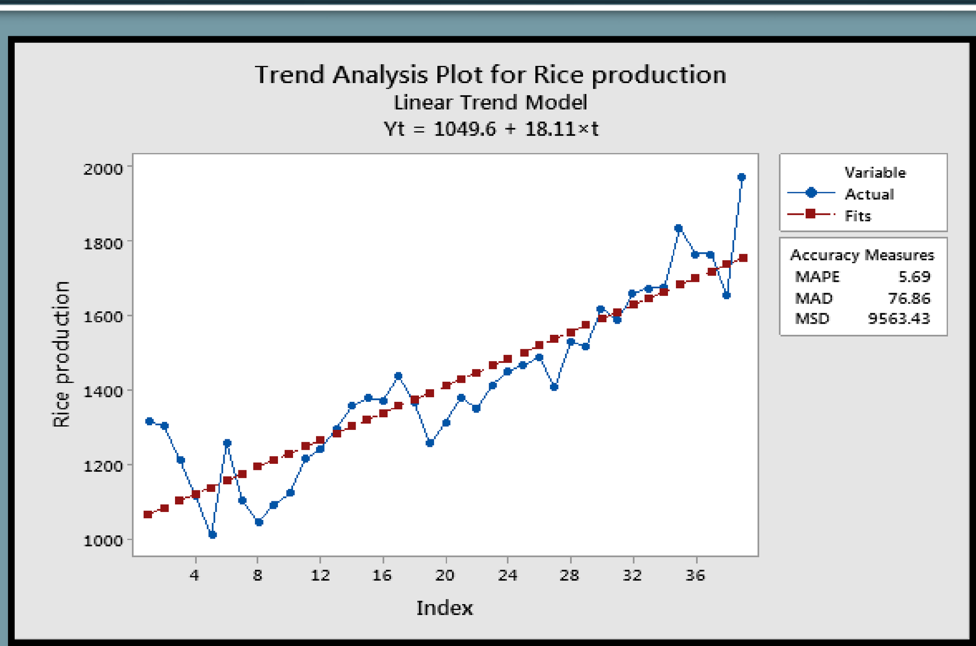


FIGURE 1

Using historical data on production of rice in Malaysia from year 1980 to 2018, a time series plot that consists of 39 observations were produced (Figure 1). The plot shows the production of rice in Malaysia was not stationary and increased over the years. However, there was a significant decrease in production for a few years, most likely due to some events that may have caused to a drop of rice production in those years.

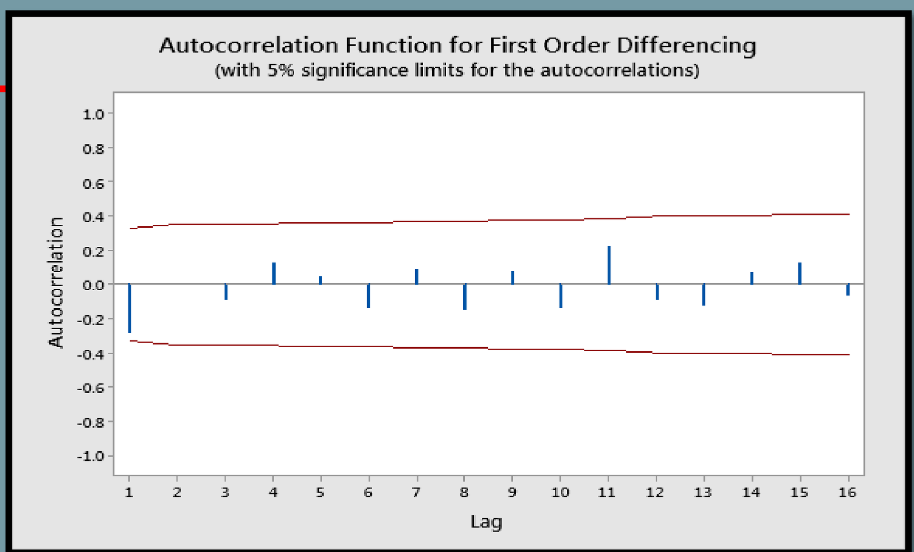


FIGURE 2

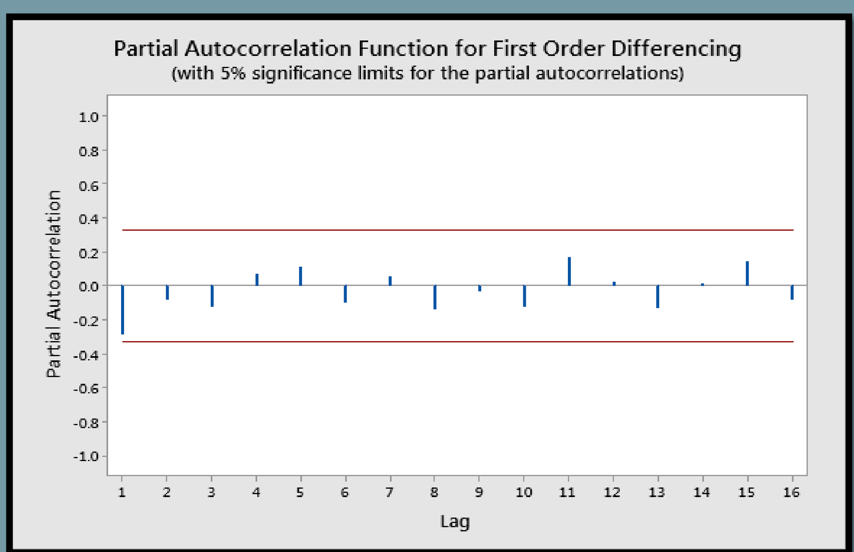


FIGURE 3

Since the data not stationary, first order differencing was performed. Based on the ACF and PACF graph (FIGURE 2 and FIGURE 3) for first order differencing, it shows that there is no decay and it conclude that the first order differencing has stationary. It was observed that partial autocorrelation had 1 significant spike at lag 1 indicate p = 1 , AR(1) while the Autocorrelation had 1 significant spike at lag 1 indicate q=1, MA(1).

Therefore, the following 3 models have been identified and estimated by using Minitab
- ARIMA (0,1,1)
- ARIMA (1,1,0)
- ARIMA (1,1,1)

Model / Statistics	ARIMA (0,1,1)	ARIMA (1,1,0)	ARIMA (1,1,1)
Calculated Q	6.1	6.29	6.01
DF	10	10	9
Tabulated Q	$\chi^2_{0.05,10} = 18.307$	$\chi^2_{0.05,10} = 18.307$	$\chi^2_{0.05,9} = 16.919$
Decision (5% sig. level)	Since cal Q(6.1) < tab Q(18.307), accept H_0.	Since cal Q(6.29) < tab Q(18.307), accept H_0.	Since cal Q(6.01) < tab Q(16.919), accept H_0.
Conclusion	The errors are white noise	The errors are white noise	The errors are white noise
MSE	8395.71	8565.7	8641.59

TABLE 1

From TABLE 1, all the models are accepting null hypothesis since all the calculated Qs values are less than tabulated Qs values for each model. Hence the conclusion is that the models are well specified and adequate. However the study only need one models among the three well specified models. Based on the smallest value of MSE, the model chosen was ARIMA (0,1,1). Forecasted value was tabulated in TABLE 2 and the time series plot with forecast sample was shown in FIGURE 3.

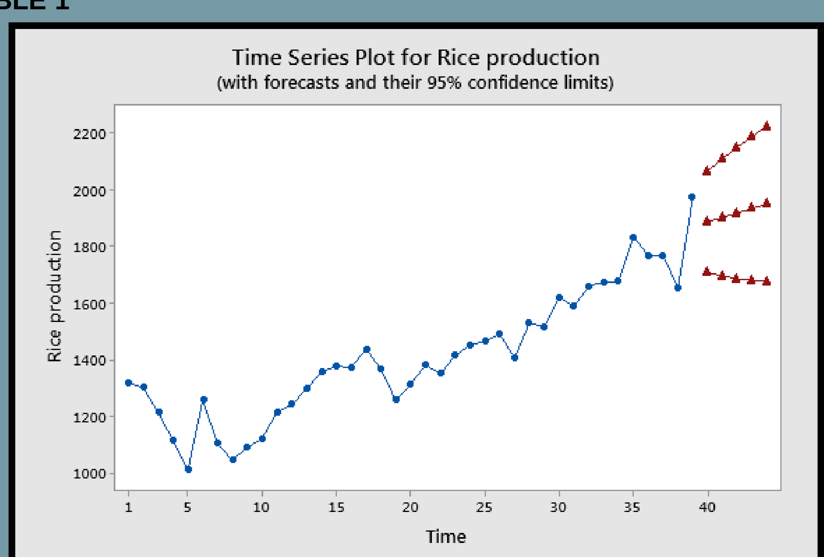


FIGURE 3

Year	Forecasted value (metric tonne)	Lower limit 95% confidence interval	Upper limit 95% confidence interval
2019	1887.333	1707.706	2066.96
2020	1902.999	1695.478	2110.519
2021	1918.665	1686.579	2150.75
2022	1934.33	1680.042	2188.619
2023	1949.996	1675.294	2224.699

TABLE 2

CONCLUSIONS

Using a univariate time series forecasting approach, it was determined that ARIMA (0,1,1) is the best model to predict rice production in Malaysia for 5 years ahead. This study found that the production of rice in Malaysia still imbalanced and insufficient to cover the Malaysian population. As a conclusion, the Muda Agricultural Development Authority (MADA) still need external imported and new effective initiative to increase the rice production.

REFERENCES

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