Model Fitting and Forecasting of Annual National Coconut Production in Sri Lanka

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ABSTRACT

Coconut plantation plays a significant role in the Sri Lankan economy. This study mainly focuses on modeling and analyzing the annual national coconut production of Sri Lanka. The annual national production data from 1964 to 2015 were used for this study. Time series models were fitted by the Box and Jenkins ARIMA approach. Series were tested for stationary using the unit root test (Augmented Dickey Fuller test). Differencing techniques were applied to transform non-stationary series to stationary series. Model diagnostics were accomplished by the residual analysis. The ARIMA (2,1,0) model was selected as the best fitting model for annual national production of coconut in Sri Lanka based on Akaike Information Criterion and the residual analysis. The prediction has been made for 2020 where the total number of nuts would be 2713 millions. Further, we have noticed a 5% reduction in total nuts produce in 2017 whereas which would be 4% by 2020. The drop in annual coconut production anticipates a higher price for coconut by 2020. Therefore, a policy initiation must be in place to face this situation of the coconut industry in Sri Lanka.

Keywords: ARIMA, Box-Jenkins, differential, modeling, stationary

Introduction and research problem

Coconut cultivation in Sri Lanka can be considered as one of the major plantation crops where the cultivation is mostly spread along the coastal line of the country. Many industries have been formulated within the country around the coconut cultivation where the exportation of coconut based products is significant. This has the highest cultivated land area compared to the other major plantation crops in the country, which contributes significantly to the agriculture sector of Sri Lanka.

The uncertainty of production of agricultural commodities over years is one of the most influential issues in Sri Lanka. For instance, in coconut sector, the national coconut production is 2584 million nuts in 2010 while it increased up to 3056 million nuts by 2015. The production fluctuation in a temporal sequence directly affects the price of domestically consumed coconut and coconut based products. Hence, a better understanding of changes of the pattern of production and forecasting of future production are considerably important in decision making process to overcome the issues emerging due to the fluctuation of coconut production in Sri Lanka.

Research Methodology

The methodology applied in this research falls into univariate stochastic analysis of time series for forecasting the future production. Therefore, this study mainly focused on Box and Jenkins ARIMA model fitting approach to forecast annual coconut production of Sri Lanka.

Data Collection

Secondary data series of annual coconut production from 1964 to 2015 was collected from the annual central bank reports of Sri Lanka. Annual national coconut production data can also be considered as a discrete time series where the data are recorded in equally spaced sequence along the time. The data analysis and the model fittings were carried out by using R software package, which is a freeware for statistical computations.

Preliminary analysis and stationary condition of the data

The summary statistics were calculated for obtaining a basic understanding of the collected data. Time series plot was used for the preliminary evaluation of existing patterns of the data series. As a unit root test for testing the stationary condition,

Augmented Dickey Fuller (ADF) test was applied. Differencing technique was applied to the series as it is required to convert non-stationary series into a stationary, in order to fit more robust model for the data.

Selecting time series models

Autocorrelation function and Partial autocorrelation function correlograms were developed for selecting possible time series models and Akaike Information Criterion (AIC) was used for selecting the best fitting model.

Validation of model

Model diagnostics checking were carried out by using Box Pierce test and forecasting while the accuracy was measured by Mean Absolute Percentage Error (MAPE) of forecasts.

Results and findings

The summery statistics of the collected data series are given below (Table 1). Table 1.

Summary statistics of collected data

Min	1st Qu.	Median	Mean	3rd Qu.	Max.
1821	2326	2539	2532	2773	3096

The developed time series plot for the data series is shown in Figure 1.

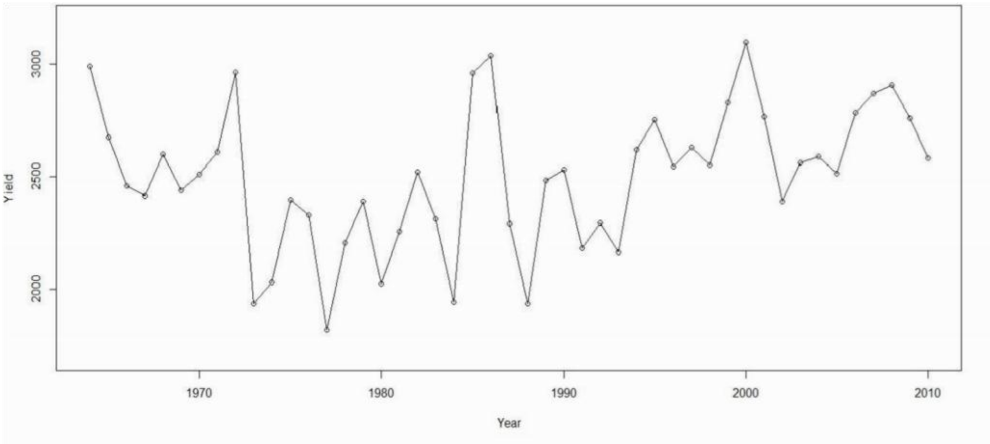

Figure 1. Time series plot for collected data

In a time series data, there can be mainly three patterns or components; trend, cyclic and seasonal, along or together by one of them. The success of the prediction for a given data set is highly dependent upon the level of tracking the patterns or components when fitting a time series model. Figure 1 shows a slight trend component beginning from late 70's to latest data point and cyclic or seasonal component is not much obvious.

The stationary time series data is essentially required for ARIMA approach and differencing technique is a very useful approach for transforming non-stationary into stationary series. The ADF test result indicated that the collected data do not satisfy the stationary condition (p= 0.3823) hence first order differencing (d=1) was applied as the initial attempt followed by ADF test which confirmed that the stationary requirement was fulfilled (p= 0.01).

Model selection is one of the difficult steps in Box and Jenkins ARIMA approach. Mainly ACF and PACF correlograms are used for selecting possible models where the best-fitted model is selected by following number of criteria.

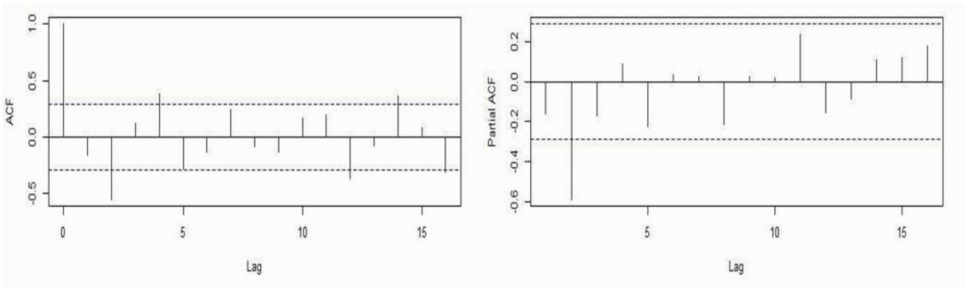

Figure 2. ACF and PACF correlogram for model identification

The possible models selected based on above (Figure 2) ACF and PACF correlograms are ARIMA (2,1,0), ARIMA (2,1,2) and ARIMA (2,1,4) where, ARIMA (2,1,0) model was selected as the best fitted according to the minimum AIC value.

All the model diagnostic checking approved the selected model by not rejecting the null hypothesis for Box-pierce test (p=0.3933) and not indicating any of the significance lag of ACF of residuals.

The calculated MAPE for the forecast by the selected model is 6.5% indicates that the accuracy of the fitted model is good. A short term forecasting up to 2020 is given in table2.

Table 2. Forecast of the annual national coconut production with 95% confidence intervals

Year	Forecast	95% Lower CI	95% Upper CI
2017	2694	1805	3583
2018	2709	1766	3650
2019	2726	1733	3718
2020	2713	1686	3738

When considering the forecast value for 2017, it indicates a 5.05% reduction compared to the average annual production from 2011 to 2015 and it further be 4.41% by 2020.This may be a result accounted by a several reasons such as reduction in productivity on the face of climate change and many other influential factors. More importantly, these predictions could not be tallied with actual figures with non-repetitive sudden influential events. However, it is highly required to apply correction strategies to overcome issue that the reduction of coconut production by 2020, which could be significantly and negatively influence the domestic consumers and coconut based industries.

Conclusions

The ARIMA approach resulted in three well-fitted time series models in this research. Out of them, the best fitted model was, ARIMA (2,1,0) and used for forecasting the short term future production. Although it shows that the short term future production is also follow the same existing pattern without huge changes, there is a 5% reduction of coconut production in 2017 which is also expected to happen in 2020 (4% reduction) as well. With this anticipated declining of coconut production, it would result in a high price of coconut by 2020. Hence, initiation of appropriate policies and management strategies are highly required in this stage to overcome the underlined issues related to the reduction in annual coconut production in Sri Lanka.

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