SMOOTHING TECHNIQUES FOR SHORT TERM FORECASTING OF COCONUT PRODUCTION IN SRI LANKA

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Abstract: The present study was designed to detect a suitable technique between the moving average and exponential smoothing techniques for short term forecasting of annual coconut production in Sri Lanka. Measures of accuracy such as Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Squared Deviation (MSD) were used in model selection criteria. Results revealed that there is upward trend in the data set. Double Moving Average (DMA) and Double Exponential Smoothing (DES) were experienced for the data set with incorporating the trend. After evaluating the all accuracy measures, DMA is prove to be the best model for short term forecasting with lower MAPE, MAD and MSD of 8.37, 204.2 and 71527.7 respectively, in which 77% data lies between ±10% of true value. Forecasted value for year 2012 was 2730 million nuts in DMA while it was 2715 million nuts in DES.

Key words: Double moving, Double Exponential Smoothing, Mean Absolute Percentage Error Mean Absolute Deviation, Mean Squared Deviation

Introduction: Coconut (*Cocos nucifera* L.) is one of the most economically important perennial crops grown in several countries within the humid tropical region in the world. As every part of the coconut palm is utilized to make different kinds of products, the coconut palm is popularly known as 'tree of life" and plays a vital role as a multipurpose tree. The main use of the coconut is to extract coconut milk directly from the unprocessed kernel for culinary preparation, which is commonly known as fresh nuts consumption at the rate of about 116 nuts per person per year in Sri Lanka. Thus, the remaining nuts are available for other industrial uses such as extracting coconut oil and manufacturing desiccated coconut, fiber, shell charcoal, coconut milk powder and cream. In addition, a small fraction of the production is used for fresh nut export. Among the coconut kernel based products, desiccated coconut is one of the major products exported. Also coconut oil, poonac, mattress fiber, coconut shell charcoal and coconut ekels are exports from Sri Lanka. Because of its many uses locally and throughout the world, the coconut palm receives attention everywhere. Considering the importance of coconut sector in Sri Lanka's economy, advanced knowledge of coconut production is vital. Annual coconut production in Sri Lanka, between 1950 and 2011, varied from 1821 million nuts in 1977 to 3096 million nuts in 2000 with mean of 2460.31 million nuts and standard deviation of 303.12 million nuts (Coconut Research Institute, Annual report). Coconut growers, policy makers, planners and scientists have faced some problems in planning, policy making and decision making, because of lack of accurate prediction information in total coconut production. This affects mainly in utilization of nuts for various sectors such as export markets, industry and government. Under the changing scenario, consistent and timely forecasting of several aspects gives vital and valuable inputs for appropriate designing and planning in agriculture. Therefore this study was aimed to find out the best model for short term forecasting for the annual national production by smoothing techniques. A time series is a sequence of observations of a random variable, which are ordered in time. Smoothing techniques are used to reduce random fluctuations in time series data. It gives an apparent idea of the true underlying behaviour of the data series. Moving average and exponential smoothing techniques are commonly adopted easy smoothing method in short term forecasting.

Moving averages: Moving averages rank among the most popular techniques for the pre processing of time series. The attractiveness of these models is its ease of application. It used to filter random white noise from the data, to make the time series smoother or even to highlight certain informational components contained in the time series. Single moving averages (SMA) method is suitable for stationary time series data where the series is in equilibrium around a constant value with a constant variance over time, while double moving average (DMA) is suitable for the series which has trend.

Exponential smoothing: Exponential smoothing is an intuitive forecasting method that weights the observed time series unequally. It is too widely used popular method to create a smoothed time series, due to simplicity, its computational efficiency, ease of adjusting its responsiveness to changes in the process being forecast and its reasonable accuracy. Also unlike regression models, exponential smoothing does not forced any deterministic model to fit the series other than what is inherent in the time series itself. Application of exponential smoothing to forecasting time series usually rely on three methods such as simple exponential smoothing (SES), trend corrected exponential smoothing or double exponential smoothing (DES) (Holt, 1957) and winter's exponential smoothing techniques. SES and DES are suitable for the without trend and with trend data series, while Holt's method is better at handling seasonal data.These methods are assumed to build from unobserved components of level and growth effects. Exponential smoothing recent observations are given relatively more weight in forecasting than the older observations. The unequal weighting is accomplished by using one or more smoothing parameters, which determine how much weight is given to each observation.

Methodology: The study was conducted to identify the best model among the smoothing techniques for short term forecast for coconut production using national yield, collected from Coconut Research Institute (CRI) in Sri Lanka from 1950 to 2011.

Identify the pattern:

At the first stage of the analysis, time series plot for yield was created and evaluated to identify the pattern of data.

Choosing the appropriate smoothing method

Because of the trend in a series, double moving average and double exponential smoothing were experienced for the national coconut production in Sri Lanka.

Double moving average (DMA)

One set of moving averages are worked out first and then a second set of moving averages is calculate from the first set is called as DMA. It is suitable when data has trend.

Double exponential smoothing (DES)

DES is better at handling trends and it provides short-term forecasts. Dynamic estimates are calculated for two components on level and trend by using two smoothing constant such as α and β.

$$L_t = \alpha y_t + (1-\alpha)(L_{t-1} + b_{t-1})$$

$$b_t = \beta\ (L_t - L_{t-1}) + (1-\beta)\, b_{t-1}$$

$$F_{t+m} = L_t + m\, b_t$$

Where,

L_t = estimate of the level of the series at time t

α = smoothing constant for the data

β = smoothing constant for trend estimate

b_t = estimate of the slope of the series at time t

m = periods to be forecast into the future

α and β (=0.1, 0.2, ...0.9) are the smoothing and trend parameters

Determination of the smoothing length and constant of the model

Selection of smoothing length for double moving models and smoothing constant for double exponential smoothing models were done based on the accuracy measures such as Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD).

Relevant statistical equations are given below.

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|Y_t - F_t|}{Y_t}$$

$$MAD = \frac{1}{n}\sum_{t=1}^{n}|Y_t - F_t|$$

$$MSD = \frac{\sum_{i=1}^{n}(Y_i - F_t)^2}{n}$$

Where,

Y_t = actual value of series in period t

F_t = forecast value

n = number of observation

Forecasting the production

By using the selected model from double smoothing average and double exponential smoothing, 2012 yield was forecasted.

Results and discussion

Identification of the pattern of the data

Time plot for coconut yield from 1950 to 2011 shows in Figure 1 and it revealed that there is increasing trend in coconut production in Sri Lanka.

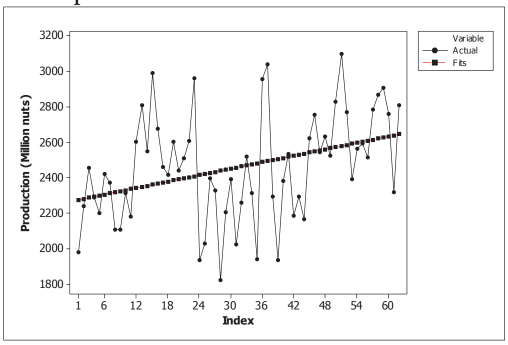

Figure 1: Time plot during 1950-2011

Double moving average :DMA models were found to be more appropriate for accounting the trend in the time series data. So, with the concern of the trend in the data, double moving average models with all possible combinations of moving lengths were tested. Lowest MAPE, was employed as the model selection criteria to select the best model. Some selected models are shown in Table 1.

Among that, lowest MAPE (8.37) MAD (204.2) and MSD (71527.7)value was recorded from the 5,2 DMA follow DMA of 2,5. For the validation of the 5,2 DMA model residual was tested and it evident that normality (Anderson-Darling test = 0.206 and P=0.865) and uncorrelation of the residual (Figure 2 and 3).

Table 1: Accuracy measures by using double moving average

Year	Fitted/forecast value		
DMA	5,2	2,5	4,3
2009	2699.0	2699.00	2690.83
2010	2750.7	2750.70	2763.42
2011	2748.0	2748.00	2771.42
2012	2730.0	2730.5	2747.92
MAPE	8.37	8.45	8.5
MAD	204.2	208.43	207.81
MSD	71527.7	70352.4	74889.9

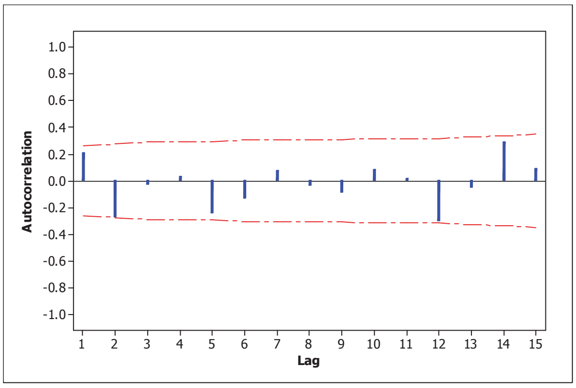

Figure 2: ACF of residual for 5,2 DMA model

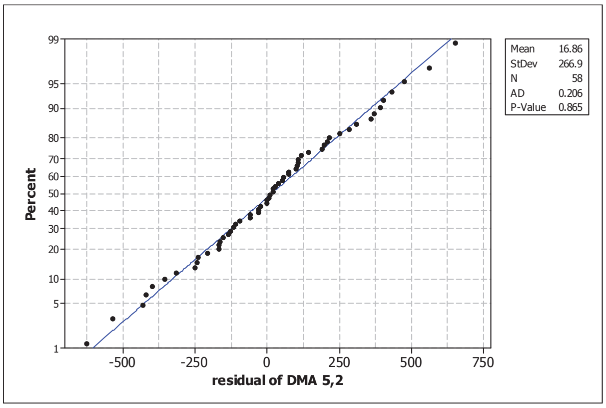

Figure 3: Normality plot of residual for DMA of 5,2

Double exponential smoothing :DES techniques known as Holt's method, was tested byvarious combinations of α and β both ranging from 0.1 to 0.9 and accuracy measure for some selected models are shown in Table 3. 0.21 and 0.01 combination of α and β respectively has higher accuracy than the rest and selected as the best model. Residual pattern was tested and it shows that the errors are uncorrelated and normally distributed. The selected model is follows;

$L_t = 0.21 y_t + (0.79)(L_{t-1} + b_{t-1})$ $b_t = 0.01\ (L_t - L_{t-1}) + (0.99)\, b_{t-1}$ $F_{t+m} = L_t + m\, b_t$

Table 2: Selected smoothing constants with accuracy measures for DES

α and β	MAPE	MAD	MSD
0.21 and 0.01	8.9	214.2	80989.4
0.21 and 0.02	8.9	215.2	81727.8
0.19 and 0.01	8.9	214.8	80912.7

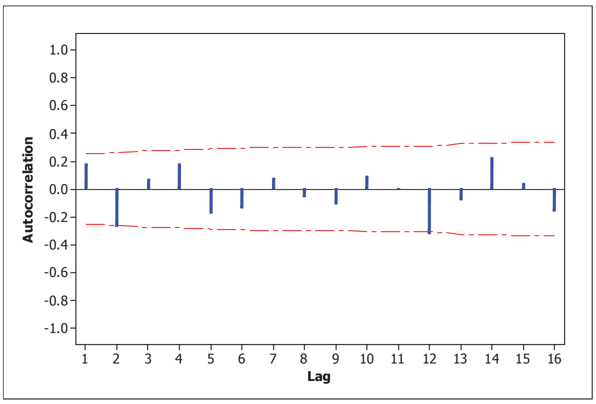

Figure 4: ACF of residual for DES

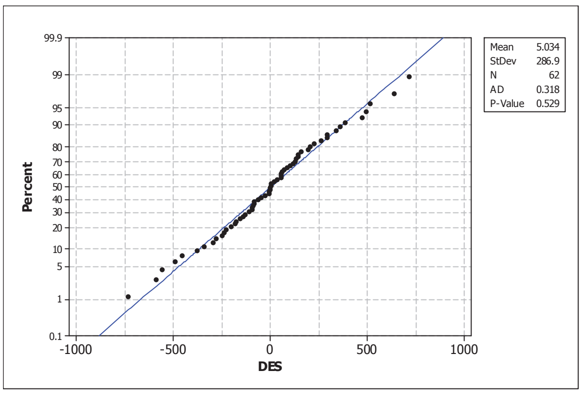

Figure 5: Normality residual plot for DES of α = 0.21 and β = 0.01

Evaluation of forecasting techniques

In this study an attempt was made to find the short term forecast of annual coconut production in Sri Lanka by using smoothing techniques. According to the trend analysis trend was noticed. DMA and DES techniques were experienced considering the trend in the data. Lower MAPE was obtained in DMA (8.37) compared to DES (8.90). After evaluating residual pattern, DMA 5,2 is prove to be the best model for short term forecasting and forecasted value for year 2012 was 2730 million nuts. 43% and 77 % of the data lie between 5% and 10% true value respectively. Once the 2012 is available (not yet available the production of 2012 figure) 2013 yield can be forecasted according to the selected model.

Conclusion

This study concluded that the best model between the tested smoothing techniques is DMA with lower accuracy measures. The advantage of using this DMA is simple and easy to use.

References:

1. Holt, C.C. (1957). Forecasting seasonal and trends by exponentially weighed moving average, Office of Navel Research, Research memorandum No. 52.
2. Coconut Research Institute, Sri Lanka, annual Reports.

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