

PRICE FORECASTING OF MANGO USING SARIMA MODEL

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Introduction

Mango, which is known as the “King of Fruits”, is in popular demand by exporters and processors in Sri Lanka. Local varieties of mango such as *Karthakolambon* and *Villad* are procured mostly from Jaffna District in comparison with other varieties of mango in the wholesale markets of Sri Lanka. Mango prices fluctuate during and across seasons due to changes in production and market conditions. These price variations insert uncertainty into the decision making of farmers, consumers and policy makers. Consequently, accurate prediction of prices is extremely useful for efficient monitoring and planning of marketing. Modeling and forecasting of the monthly price of mango over the years would provide an essential basis for such an exercise. Hence, the objectives of the study are to identify the price trend of mango over the years, to suggest a suitable time series model for price forecasting and to forecast the prices for a short term.

Methodology

The Seasonal Auto-Regressive Integrated Moving Average (SARIMA) model has been used by Chandran & Pandey (2007) to forecast the prices of potato in Delhi market. The seasonal univariate Box-Jenkins model, often referred to as SARIMA is one of the important and useful tools for time series modeling (Box et al., 1994). It requires differencing non-stationary series one or more times to achieve stationarity. The model includes different operators, autoregressive terms, moving average terms, seasonal difference operators, seasonal autoregressive terms, and seasonal moving average terms. The first step in developing this model is to determine if the series is stationary and if there is any significant seasonality that needs to be modeled.

The data employed in this research comprises monthly wholesale market prices of selected fruit varieties collected from the Department of Agriculture, Jaffna covering 2004 to 2014. Under this study, the average wholesale market prices for *Karthakolambon* and *Villad* were considered separately. Stationary and non-stationary properties were checked by applying time series plot, Auto-correlation function and Partial auto-correlation function. The SARIMA model takes into account the seasonal characters of the time series data (Fenyves et al., 2008). The model is useful when the time series data exhibit seasonally-periodic fluctuations that recur with about the same intensity each year (Martinez et al., 2011). Therefore, the SARIMA (P,D,Q) (p,d,q) model was applied by using thirty different versions, where P = number of seasonal autoregressive (SAR) terms, D = number of seasonal differences, and Q = number of seasonal moving average (SMA) terms. The p-values of the above estimated parameters were hypothesized as following.

Null hypothesis: Estimated parameters are not significant (Data is not stationary)

Alternative hypothesis: Parameters are significant (Data is stationary)

Decision rule: If p-value of estimated parameters > 0.05, data are not stationary

Box-Pierce chi-squared statistics were written as:

Null hypothesis: Parameters are significant

Alternative hypothesis: Parameters are significant

Decision rule: If p-value of Box-Pierce chi-squared statistics < 0.05, parameters are not significant and should be rejected

After considering various SARIMA versions, the most appropriate one for price forecasting was obtained by choosing the model which yielded minimum error measurements such as Mean Absolute Percentage Error, Mean Absolute Deviation and Mean Squared Deviation. Finally, a time series plot was observed between actual value and forecast value after model- fitting. Also, multiplicative decomposition analysis was performed for each variety of mango to observe seasonality.

Results and Discussion

Karthakolambon

After considering Box-Pierce statistic and estimated parameters, the best model for forecasting was chosen as SARIMA (1, 0, 0) (0, 1, 1)₁₂, which yielded a p-value of more than 0.05 (Box-pierce statistic). At the same time, estimated parameters have a p-value lower than 0.05 in this model. See Table 1 below.

Table 3.1: Goodness of Fit of the Different Models for *Karthakolambon*

Model Type	Model	MAD	MSE	MAPE
SARIMA (p, d, q) (P, D, Q) _I	SARIMA(1,0,0)(0,1,1) ₁₂	14.1936	472.665	0.3607

Price of *Karthakolambon* decreased to Rs.74 (per fruit) for May, 2015 and increased again by July, 2015 as shown in Figure 1. With the forecasting pattern, seasonal variations of prices can be identified clearly. When comparing the forecasting price with observed price in year 2014, price of *Karthakolambon* decreased as whole in forecasting horizon.

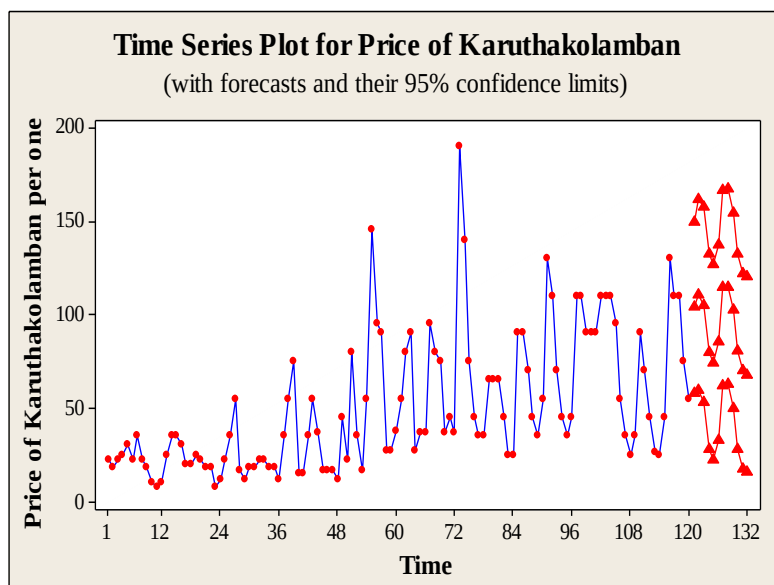


Figure 1: Forecasting Time Series Plot of *Karthakolambon*

Under the multiplicative model, seasonal analysis reveals the availability of mango with low prizes as shown in Figure 2. Price of *Karthakolambon* is low from April to June and from October to December and is readily available in the market in these periods.

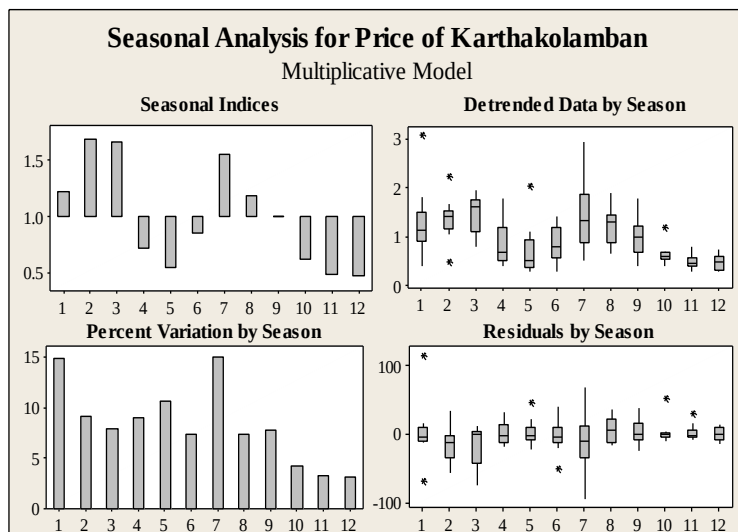


Figure 2: Decomposition Analysis for Price for *Karthakolambon*

Villad

Table 2 shows selected models for forecasting of prices of *Villad* variety after considering the Box- Pierce statistic and estimated parameters. Thereby, SARIMA (0, 0, 1) (0, 1, 1)₁₂ is the best model for forecasting which has least values of residuals. Also, this model suggests that price of *Villad* is affected by seasonal variations.

Table 2: Goodness of Fit of the Different Models for *Villad*

Model Type	Model	MAD	MSE	MAPE
SARIMA (p, d, q) (P, D, Q) _l	SARIMA(1,0,0)(0,1,1) ₁₂	7.50576	103.035	0.473094
	SARIMA(0,0,1)(0,1,1) ₁₂	7.50149	102.782	0.480698
	SARIMA(1,1,1)(0,0,1) ₁₂	7.58670	131.263	0.511726

Price of *Villad* increases up to Rs.30 in January, 2015 as shown in Figure 3. After that, there is a price increment up to Rs.55 in March, 2015. Then

price decreases to Rs.32 and follows a horizontal pattern from April, 2015.

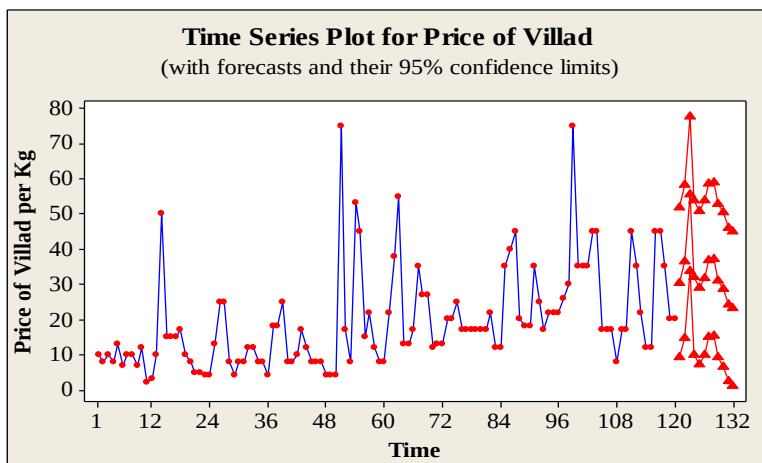


Figure 3: Forecasting Time Series Plot of *Villad*

Figure 4 shows seasonal analysis of price for *Villad*. When considering the graph there are two seasons that we can observe clearly. One season is from April to June and another season is September to December. Price was low in these seasons where *Villad* variety is highly available. Further, *Villad* variety may not be available in January and August.

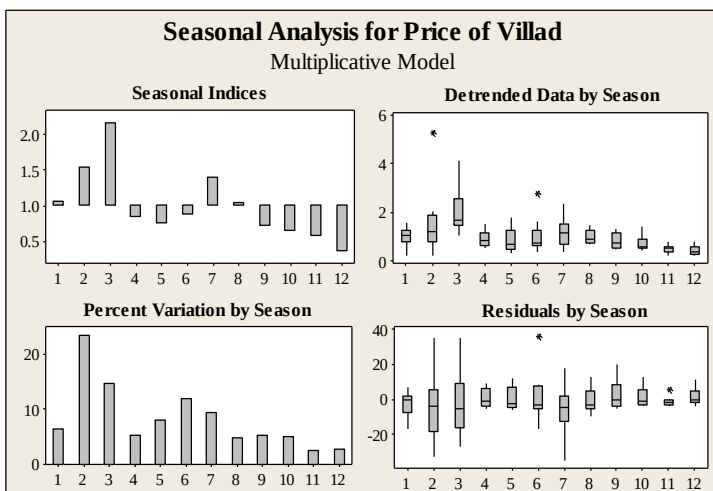


Figure 4: Decomposition Analysis for Price for *Villad* Variety

Conclusion

Prices of selected mango varieties have been increasing from 2004-2014. Also, forecast prices of mango differ slightly from actual price. Among fixed thirty versions, SARIMA (1, 0, 0) (0, 1, 1)₁₂, SARIMA (0, 0, 1) (0, 1, 1)₁₂ are the most suitable models for forecasting of prices of *Karthakolambon* and *Villad*, respectively. Therefore, SARIMA model turns to be a good model for forecasting prices of mango in Jaffna district. Forecast prices can help farmers, consumers and policy makers in planning production, marketing and purchase of these varieties.

References

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