PADDY PRODUCTION PATTERN AND FUTURE FORECASTING OF BATTICALOA DISTRICT: A TIME SERIES ANALYSIS

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Introduction

Batticaloa, important paddy producing area accounts for about 4% of the national annual paddy output with about 180,000 metric tons in 2006 and sharply lower thereafter. About two thirds or more of the annual output is obtained during the Maha season, producing about two thirds of the total (Department of Census and Statistics, 2010).It had increasing trend of paddy production in the past and thereafter it has reduced a lot. The Eastern Province is estimated to have maintained its relative share of National Gross Domestic Product during the period 1996-2006 at about 4-5% of the total. As the trend line indicates, the trend in the provincial share of the total output of the country declined. With this background, the specific objectives are i) to investigate the past, present and future trends of paddy production in Batticaloa District and ii) to develop a time series model to detect the long term trend and prediction for future changes of paddy production for the three leading years in Batticaloa District. Thattil and Walisinghe (2000), have used ARIMA and regression models to create database for climate, price and production data on paddy, district wise and each of the seasons, maha and yala and used the database to derive prediction models forecasting paddy yields for following three years. They have found that forecasting of yields using ARIMA in combination with multiple regression models was very similar for maha but not for yala and the actual yields realized are closer to the forecasting made using a combination of ARIMA and regression models.

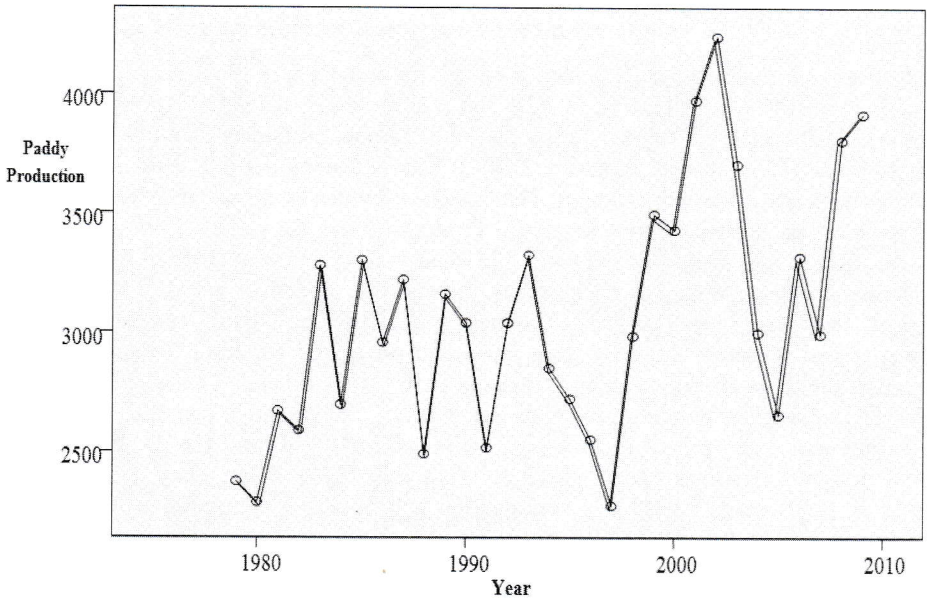
Methodology

Time series forecasting analysis utilized the published secondary data of the Department of Census and annual reports of Central Bank of Sri Lanka. Time period for the production data of 1952 to 2009 was used for the analysis. Time series forecasting analysis was carried out using statistical software SPSS. The time series analysis was done to fulfill the objective of detecting the trend and predicting for future changes of paddy production for the three leading years in Sri Lanka by developing a model according the behavior of the data. The ARIMA model was used to fit the data set which is complement to the trend regression approach and forecasting of the concerned variable to the near future (Box et al., 1994). Since annual value of the concerned variable was used, a univariate non seasonal ARIMA (p,d,q) was used. Modeling was done by four stages such as Identification process, Estimation, Diagnostic testing and forecasting. Autocorrelation and partial autocorrelation functions were calculated and appropriate Box-Jenkins ARIMA model was fitted. Validity was tested using standard statistical techniques. The forecasting power of ARIMA model was used to forecast paddy production.

Discussion and Conclusion

ARIMA model was estimated only after transforming the variable under forecasting into a stationary series. The stationary series is the one whose values vary over time only around a constant mean and constant variance. There are several ways to ascertain this. The most common method is to check stationarity through examining the graph or time plot of the data. Figure 1 revealed that the data was nonstationary. Non-stationarity in mean was corrected through appropriate differencing of the data. In this case difference of order 1 was sufficient to achieve stationarity in mean. The newly constructed variable Xt can now be examined for stationarity. The graph of Xt was stationary in mean. The next step is to identify the values of p and q. For this, the autocorrelation and partial autocorrelation coefficients of various orders of Xt are computed (Table1). Then entertained three tentative ARIMA models and chose that model which has minimum AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion). The models were ARIMA (2, 1, 0), ARIMA (2, 1, 1) and ARIMA (2, 1, 2). Among the above models ARIMA (2, 1, 0) was the most suitable model as this model has the lowest AIC and BIC values.

Figure 1: Time plot of paddy production data



Results of estimation are reported in table 1. The model verification is concerned with checking the residuals of the model to see if they contain any systematic pattern which still can be removed to improve on the chosen ARIMA. This is done through examining the autocorrelations and partial autocorrelations of the residuals of various orders. For this purpose, the various correlations up to 14 lags were computed and the same along with their significance which is tested. As the results indicate, none of these correlations is significantly different from zero at a reasonable level. This proves that the selected ARIMA model is an appropriate model. The ACF and PACF of the residuals also indicate 'goodness of fit' of the model. So the fitted ARIMA modelfor the paddy data,

$$\mathbf{Z_t = 3065.275 + 2.575\, Z_{t-1} - 2.16\, Z_{t-2} + 0.597\, Z_{t-3} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)}$$

The principal objective of developing an ARIMA model for a variable is to generate post sample period forecasts for that variable. This is done through using equation (1). The forecasts for paddy production during 2010 to 2012 are given in lower part of table 2. The estimated value for paddy productions in 2010, 2011 and 2012 are 3960140 Mt, 40150600 Mt and 4066540 Mt respectively.

Table 1: Estimates of the fitted ARIMA Model

		Estimates	Std Error	t	Approx Sig
Nonseasonal Lags	AR 1	1.575	.308	5.120	.000
	AR 2	-.595	.191	-3.125	.004
Constant		3065.275	141.027	21.735	.000
Number of Residuals	31				
Number of parameters	3				
Residual Df	27				
Adjusted Residual Sum of Squares	5624071.904				
Residual Sum of Squares	6468272.155				
Residual Variance	202646.629				
Model Std. Error	450.163				
Log-Likelihood	-231.762				
Akaike's Information Criterion (AIC)	471.523				
Schwarz's Bayesian Criterion (BIC)	477.259				

Table 2: Estimated values of paddy production and 95% confidence limit (CL)

Year	Estimated Production (000 Mt)	Lower CL	Upper CL
2010	3960.14	3029.54	4890.74
2011	4015.06	2875.58	5154.55
2012	4066.54	2702.14	5430.94

ARIMA model offers a good technique for predicting the magnitude of any variable. Its strength lies in the fact that the method is suitable for any time series with any pattern of change and it does not require the forecaster to choose a priori the value of any parameter. Its limitations include its requirement of a long time series. Often it is called a 'Black Box' model. Like any other method, this technique also does not guarantee perfect forecasts. Nevertheless, it can be successfully used for forecasting long time series data.

In this study the developed model for paddy production was found to be ARIMA (2, 1, 0). The forecasts for paddy production during 2010 to 2012 are 3960140 Mt, 40150600 Mt and 4066540 Mt respectively, where productions for the following years are increased slightly. The validity of the forecasted values can be checked when the data for the lead periods become available. The actual harvested value for the year 2010 would be lower due to heavy flood destruction in Batticaloa. Therefore, the forecasting of the climatic factors such as rainfall and temperature also necessary in addition to the production forecast for better planning purposes. The model can be used by researchers for forecasting of paddy production in Sri Lanka. However, it should be updated from time to time with incorporation of current data.

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