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ARIMA modelling to forecast area and production of apple in Himachal Pradesh

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ABSTRACT

In the present study an attempt was made to develop the statistical model, ARIMA for the estimation of apple area and production in Himachal Pradesh. ARIMA (0, 1, 0) and ARIMA (1, 1, 5) were the best fitted models for forecasting of apple area and production respectively in the state. The model exhibits good accuracy level for future projection of area and production of apple in Himachal Pradesh.

Keywords: Apple; ARIMA; forecasting; area; production

INTRODUCTION

Apple is the most important temperate fruit crop of northwestern Indian Himalayan region. In India the commercial cultivation of apple is largely confined to the states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand which together account for 99 per cent of total production. Jammu and Kashmir and Himachal Pradesh known as the Apple States of India together produce more than 90 per cent of the total apples produced in India. Apple is largely produced in the districts of Shimla, Kullu, Kinnaur, Mandi, Chamba, Sirmaur and Lahaul-Spiti (Bodh 2017). Forecasting the fruit yield is of great significance to the orchardists as it gives an idea to prepare an early estimate for harvest management, auction, transportation, storage, marketing and processing of fruit crops. The methods currently being used for forecasting apple yield are based on eye estimates and are subjective. To have probabilistic approach in yield forecast the development of statistical model is required. Development of best possible model for the problem under consideration is the selection of independent variables, model form, estimation procedure and model validation techniques. Hence in the present study an attempt has been made to predict the apple yield forecasting models.

METHODOLOGY

Separate time series data of area and production of apple in Himachal Pradesh were collected over the period 1980-1981 to 2014-15. The compound growth rates for area and production of apple in Himachal Pradesh were computed by fitting the compound function $Y = ab^t$ for the period 1980-1981 to 2014-15. Statistical model (ARIMA) was tried for the development of model for the estimation of apple area and production in the state.

RESULTS and DISCUSSION

Area under apple has been showing a steady growth in all the districts of Himachal Pradesh. The area growth was quite impressive and significant in the districts of Chamba (6.41% per annum) and Kinnaur (4.95% per annum) during the period 1980-81 to 2014-15. There has been creditable stride in increasing the apple production but the incremental production has come mainly as a result of area expansion while the productivity of this fruit is low as compared to advanced countries. The production of apple has been showing a steady growth in all the districts except Sirmour. The two districts viz Kinnaur and Chamba (high growth districts) have recorded a

significant increase in the production at a compound rate of 7.40 and 3.28 per cent per annum respectively.

Prediction of area and production: In view of globalization it is imperative to study the trend of yield/ production of different commodities by employing sound statistical modelling techniques that in turn would be beneficial to the planners in formulating suitable policies to face the challenges ahead. Before estimating the parameter (p,q) of model sample, ACF (autocorrelation function) and PACF (partial autocorrelation function) of differenced series were estimated. Fig 1 shows the autocorrelation and partial autocorrelation functions of the historical observations of the area and production of apple in Himachal Pradesh. From the area correlogram two facts are evident. First the ACF declines very slowly. ACF up to 15 lags is positive (and thereafter negative up to 16 lags) and is individually statistically different from zero. Secondly after the first lag the PACF drops dramatically and all PACFs are statistically non-significant. The autocorrelations do not drop out quickly for higher lags and time plot of the given series shows an increasing trend indicating it to be a non-stationary series. In case of apple production after the third lag the PACF drops abruptly and all PACFs are statistically non-significant.

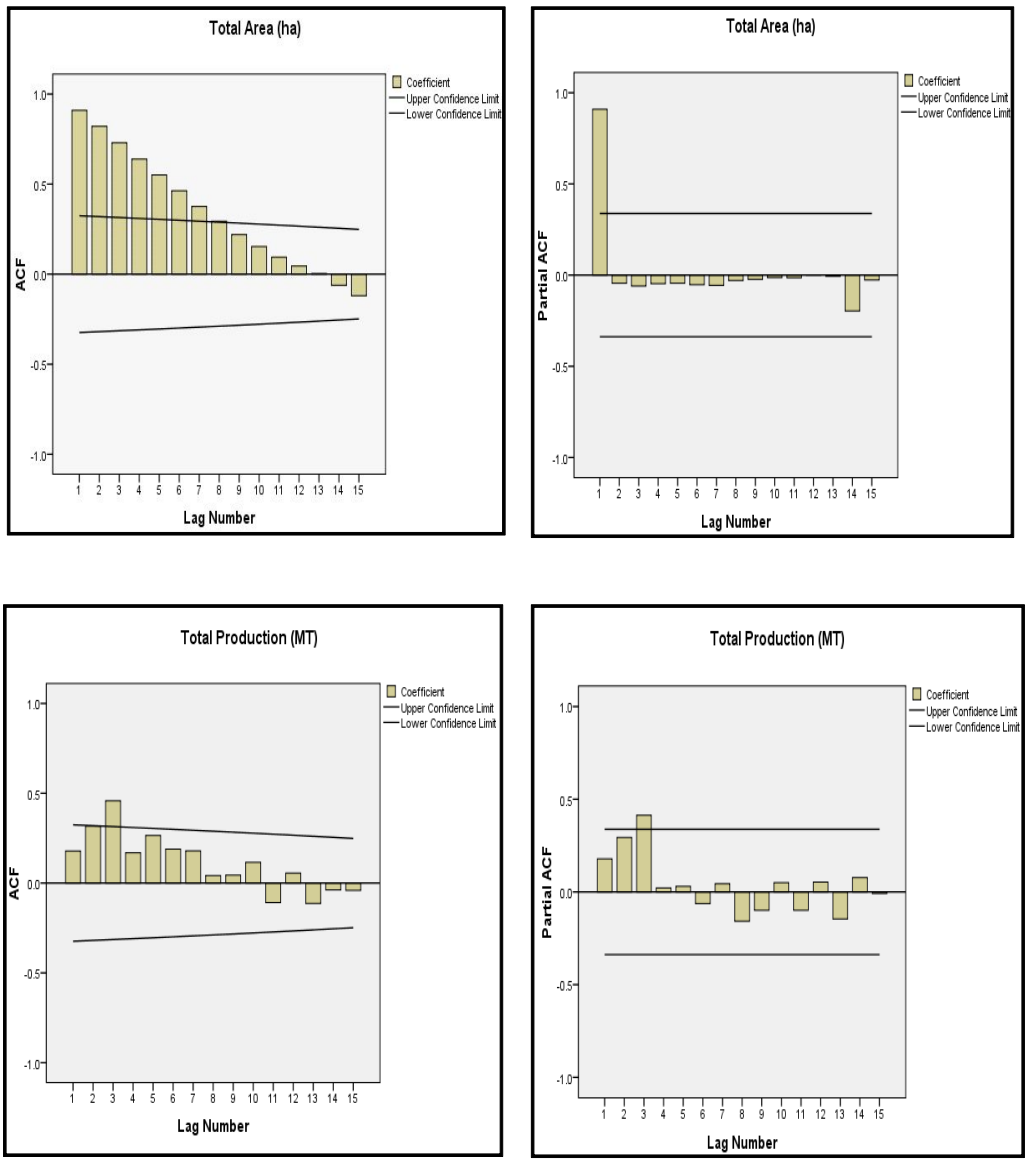

Fig 1. ACF and PACF and correlogram of area and production of apple

The PACF of the univariate time series data of area under apple had the first spike significant while in case of production data the third spike was found to be highest and significant followed by all others as non-significant. Therefore both the series possessed the ARIMA system as the other PACF spikes had a wave with positive and negative values.

The selected models for area under apple were ARIMA (0,1,0), ARIMA (0,1,4), ARIMA (1,1,1), ARIMA (1,1,3) and ARIMA (1,1,4) while models ARIMA (0,1,1), ARIMA (1,1,1), ARIMA (1,1,4), ARIMA (2,1,4) and ARIMA (1,1,5) selected for apple production. All these criteria [R^2, Ljung-Box Q (18), half splitting technique] revealed that ARIMA (0,1,0) and ARIMA (1,1,5) were the best fitted models for forecasting of area and production of apple respectively in the state of Himachal Pradesh. The actual, predicted and forecast for apple area and production are presented in Table 1 (Figs 2, 3). Similar findings were made by Mishra et al (2013) and Biswas and Bhattacharyya (2013).

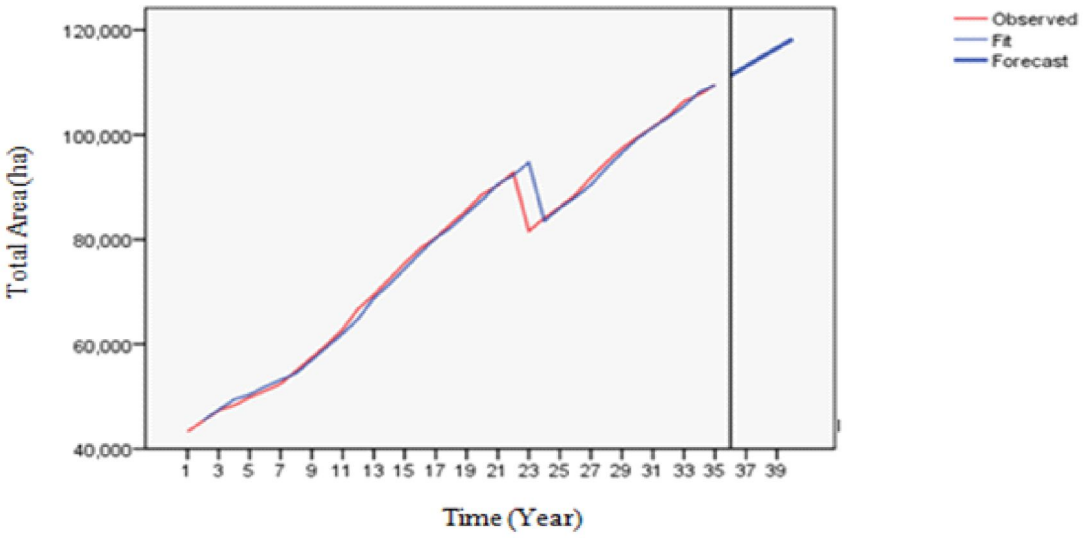

Fig 2. Forecast for area of apple in Himachal Pradesh through ARIMA

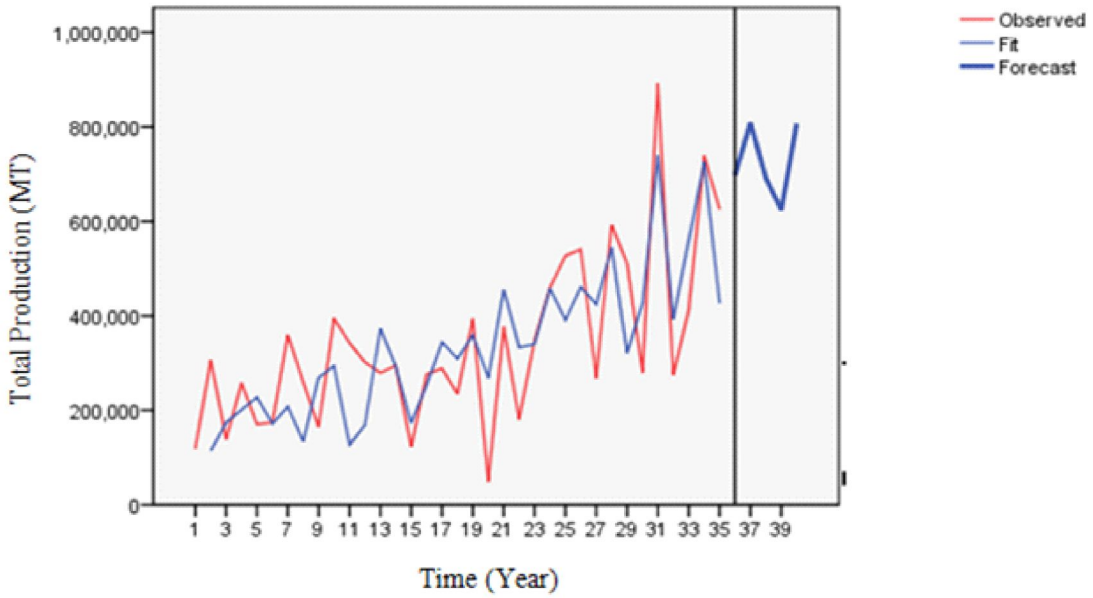

Fig 3. Forecast for the apple production in Himachal Pradesh through ARIMA

Table 1. Forecast of area and production of apple in Himachal Pradesh for the period of 2015-16 to 2019-2020

Year	Area (ha)	Production (MT)
2015-16	111321.88	697616.64
2016-17	113080.54	808710.18
2017-18	114828.97	691206.21
2018-19	116567.20	624603.87
2019-20	118295.20	807127.14

SUMMARY

ARIMA (0,1,0) and ARIMA (1,1,5) were the best fitted models for forecasting of area and production respectively of apple in Himachal Pradesh. The model exhibits good accuracy level for future projection of area and production of apple in the state.

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