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FORECASTING MODEL OF PADDY PRODUCTION IN ANDHRA PRADESH USING AUTO REGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA)

Statistics

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ABSTRACT

Paddy is the main cereal crop in Andhra Pradesh occupying 4.176 M ha area out of which rabi. Paddy occupied maximum area of 3.112 M ha during the year 2009-10. In general, forecasting is more sensitive and difficult with food crops due to their nature and seasonality. Paddy crop is the one of the important market in Andhra Pradesh. The Auto Regressive Integrated Moving Averages (ARIMA) models are used to predict and model Paddy yield (kg/Hectare). It is very useful model for predicting and maintains the agricultural market production, this article attempted for predicting of Paddy Yield (kg/Hectare) using ARIMA method for the period of 1966 to 2011. The best model has been selected based on the maximum R^2 and minimum Bayesian Information Criterion (BIC) values. It has been found that ARIMA (2 1 2) Model, the coefficient of determination (R^2) was 0.824 and Maximum Absolute Percentage (MAPE) was 13.98%. This ARIMA model is successfully validated using advanced statistical techniques.

KEYWORDS

ARIMA, Paddy Production, Forecasting and Andhra Pradesh

INTRODUCTION

In Andhra Pradesh rice is the major food crop grown in 34.40 million hectares producing 105.40 m.t in both Kharif and Rabi seasons with an average productivity of 3.02 t/ha during 2010- 11. At national level A.P is contributing 12.7% of rice production with 9.08% rice area. The increase in rice area, production and productivity mainly depends on the rainfall and availability of irrigation. The rice area, production and productivity for the last ten years are furnished.

The main rice growing season of the state is Kharif (Wet season) with 60% of total rice being cultivated during the season. The season starts from May-June and ending November-December. The Rabi (Dry Season) falls between the months of November-December to March-April and 35% of rice is grown in rabi. Edagaru (Summer) is another season where rice is grown during summer from March-April to July-August.

Time series is the collection of observations made sequentially over time and methods of analyzing this data of time series constitute an important area of statistics.

MATERIALS AND METHODS

The data was collected directorate of economics and statistics in Andhra Pradesh (http://eands.dacnet.nic.in/) over a period of 1981 to 2011 year (30yesrs) . The ARIMA model was applied on the data. The majority of time series data normally used forecasting models like linear and different growth models.

In this study ARIMA model was adapted and identify the significant parameters using Box-Jenken's methodology. The ARIMA (p d q) model is churn of autoregressive (AR) and moving average (MA) models shoes that there is relation between observed value and expected value and residuals respectively. The Box-Jenken's methodology was applied for time series data identified best ARIMA models and their residual analysis used MAPE analysis. For evaluating the adequacy of AR, MA and ARIMA process, various consistent measures like

Autoregressive Model (AR) (p); $Y_t = \theta_0+\theta_1 Y_{t-1} + \theta_2 Y_{t-2} \ldots \pm \theta_p Y_{t-p} + \epsilon_t$---(1)

Moving Averages (MA) (q); $Y_t = \theta_0 - \emptyset_1 \epsilon_{t-1} - \emptyset_2 \epsilon_{t-2} - \ldots - \emptyset_q \epsilon_{t-q} + \epsilon_t$--- (2)

The general form of ARIMA model (p d q) is

$$Y_t = \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \ldots\ldots + \theta_p Y_{t-p} - \emptyset_1 \epsilon_{t-1} - \emptyset_2 \epsilon_{t-2} \ldots \emptyset_q \epsilon_{t-q} + \epsilon_t$$

Diagnosis of the model

This model is diagnosed using the Ljung-Box Q statistics to check overall adequacy of the model. The Q statistics is

$$Q_n = nr(nr+2)\sum_{l=1}^{n} \frac{r1^2(e)}{nr-l}$$

Where $r_1(e)$ is the residual autocorrelation at lag l
nr is the number of residuals, n is the number of time lags includes in the test. For model to be adequate, p-value associated with Q statistics should be large (p-value>α).

RESULTS AND DISCUSSION

In this section, model identification phase. Among the various methods and literature studied to judge the appropriate model, we used Normalized Bayesian Information Criteria (BIC). According to this model with least BIC value will be selected. The model found ARIMA (2 12) is the best suited model based on Normalized BIC value.

Table 1: Comparison of ARIMA models

ARIMA (p d q)	R-Square	MAPE (%)	BIC value
2 1 0	0.819	14.002	10.026
2 1 1	0.819	13.982	10.134
3 1 0	0.819	13.976	10.134
1 1 2	0.793	14.323	10.265
2 1 3	0.827	14.077	10.309
2 1 2	0.824	13.988	10.212
3 1 1	0.819	13.909	10.241
1 1 3	0.814	13.918	10.270
3 1 2	0.819	13.994	10.353
3 1 3	0.825	13.819	10.428

Table 2: Paddy Yield Estimation of parameters for ARIMA Model (2 1 2)

Model fit statistics	
R-squared	0.824
MAPE (%)	13.988
Normalized BIC	10.212
Ljung-Box Q-Statistics	9.990

The ARIMA (212) model is selected using Paddy Yield. The SPSS 20.V is used for model identification and forecasting. Total 30 years (1981 to 2011) of the data evaluations and forecasted.After the identification of the model and its accuracy check, the model used to forecast the sales of Paddyyiled in the next periods Hence, we used the identified ARIMA model (2 1 2) to forecast the 2025. The forecasting results are presented (figure: 2). The Paddyyield data was taken in Andhra Pradesh. The proposed model is fit in to the current data set. The ARIMA model (2 1 2) is applied on the Paddy crop in 45 years and forecasting is done using the rest of the year data. The residuals, actual and prediction data shows consistently moving the same trend.

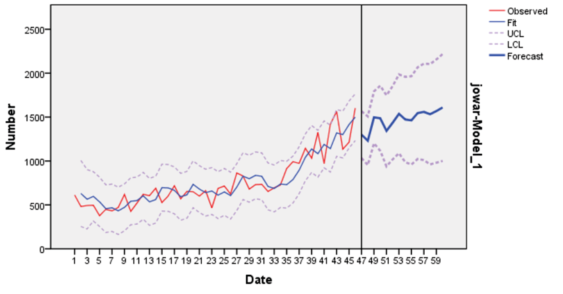

Figure 2: Trend values of Paddy production with UCL and LCL

The model parameters of the ARIMA (2 1 2) shows that sales in the last two periods is highly influencing the crop in the current period. It can be inferred that, the sales in the past periods and the months affects the Paddy yield demand in the current period. The reason that can be lack of proper storage facilities and market information. Most recent 45 years ofPaddy crop data used for modeling purpose, in this model requirement looked at the plots of auto regressive function (ACF) and partially auto regressive function (PACF) for average sales of Paddyyiled Time series plot of production showed an increasing trend. ACF of both series shoed non stationary as ACF not fall as quickly as the log K increase.

Observed, forecasted Paddy crop data obtained from ARIMA model (2 1 2) was shows table: The accuracy of the proposed model is judged based on the MAPE value. The outcome of the Paddyyield sales forecasting demand of accuracy is 24.19%. It is highly statistically significant at 0.01 levels. The r-squared values is 0.82, it means 82% of variation explained by independent parameters.

Table:3 Forecasted values of Paddy in the period 2012 to 2025

Year	Forecast	UCL	LCL
2012	1300	1567	1033
2013	1231	1508	954
2014	1498	1793	1202
2015	1486	1857	1115
2016	1343	1748	938
2017	1437	1854	1020
2018	1537	1986	1089
2019	1473	1958	988
2020	1463	1966	959
2021	1546	2068	1024
2022	1559	2108	1010
2023	1533	2104	962
2024	1569	2156	981
2025	1609	2217	1001

CONCLUSION

This proposed model applicability of ARIMA models in wholesale market to forecast the demand of on monthly basis. This model very useful to predict demand prices of Paddy yield sales for future trends. The forecasted values and observed values very close each other. The accuracy of the model was 82% and Maximum Absolute Percentage Error was 13.98%. This prediction model can facilitate the farmers and wholesalers in effective making.

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