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

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A R T I C L E I N F O

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A B S T R A C T

This paper attempts to predict the future production of Ragi (Kg. /Hectare), cultivated and consumed in Andhra Pradesh. Considering the data of Ragi production during the tenure of 1966-2012, ARIMA method, a kind of basic time series analysis is employed here to forecast the production of Ragi upto the year 2017 by utilizing the most popular computer statistical package namely, SPSS. The best predicted model has been selected based on the maximumR^2, minimum Bayesian Information Criterion (BIC) and Maximum Absolute Percentage Error (MAPE). It has been found that ARIMA (2 1 2) model is fit to describe the Ragi production data of Andhra Pradesh used here.

INTRODUCTION

Ragi is grown in more than 25 countries in Africa and Asia. Major producers of Ragi in the world are Uganda, India, Nepal and china. It is the minor cereals of the grass family. Ragi consists of all the required amino acids, it is the staple food in different parts of India and abroad. It helps to improve the metabolic rate of the body and helps to reduce bad cholesterol. It is promoted as a healthy food, which is popularly known as" finger millet", it is an annual cereal plant in India and Africa. It is widely cultivated in east Africa and tropical Asia and cultivated in uplands of Himalayas also. It is rich in its nutritional values and medicinal properties. Although it does not enter into the international markets as a trade item but in adaptation areas it is an important crop. As per an estimate, 80 percent of the world's Ragi production is used as food, the remainder being divided between feed (7 percent), other uses and waste. Ragi is also used as folk medicine. The major Ragi products are Ragi Flour, Ragi Malt, Ragi Malt weaning food, Ragi Weaning food and Ragi based energetic foods. Ragi is cultivated on around 38 million hectares across the world. Global Production of Ragi is currently about 28 million tons.

Ragi is one of the oldest crops in India. India is the largest cultivator of Ragi. It is the ancient millets in India (2300BC) which is mainly grown in the states of Andhra Pradesh, Tamilnadu, Karnataka, Orissa, Bihar, Gujarat, Maharashtra and also in the hilly regions of Uttar Pradesh and Himachal pradesh. Ragi global production is nearly 60% in India. Ragi is used in variety of ways it can be a substitute to rice and other grains. The area under the Ragi cultivation in early sixties was around 2.6 hectares. The total area under cultivation was around 16.41 lakh hectares in 1999- 2000 & 2001-02 which accounts for 1% of total food grains and 1.66 million hectares in 2003-04. The annual production is around 2.6 million tonnes with productivity of around 1400 kg/ha. Maximum area under Ragi cultivation is in Karnataka which is around 893 thousand hectares. Maximum productivity of Ragi is seen in Karnataka, Tamilnadu and Andhra Pradesh. The area under Ragi cultivation and production of Ragi are slowly coming down year by year.

Ragi is an important staple food grain crop in Andhra Pradesh along with Rice, Bajra and Jowar. In Andhra Pradesh, the total area under Ragi has come down from 2.26 lakh hectares in 1984-85 to 0.99 lakh hectares in 2000-01, similarly total production has slide down to 1.2 lakh tones in 2000-01 from 2.45 lakh tones in 1980-81. At present, around 50% of total households are growing Ragi in Tribal areas, it is mainly grown in coastal Andhra, which accounts for 58% of total Ragi growing area of Andhra Pradesh and produces 54% of total Ragi production of Andhra Pradesh. However, 85 % of the total area under this crop lies in Srikakulam, Vizianagaram, Visakhapatnam, Anantapur, Chittoor.

MATERIALS AND METHODS

The time series data was obtained from Directorate of Economics and Statistics, Andhra Pradesh (http://eands.dacnet.nic.in/). Most of time series data commonly used as forecasting models like linear and non linear models.

In this study ARIMA model was used and identified the significant parameters using Box-Jenken's methodology. The ARIMA (p d q) model is churn of autoregressive (AR) and moving average (MA) models show that there is a 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 R^2 and Bayesian Information Criterion (BIC) were used.

The time series data follows the Box-Jenkins (1970) methodology for modeling, generally known as ARIMA. Let Y_t be a discrete time series variable which takes different variable over a period of time. The corresponding AR (p) model of Y_t series, which is the generalization of the autoregressive model, is expressed as;

AR (p); $Y_t = \alpha_0+\alpha_1 Y_{t-1} + \alpha_2 Y_{t-2}\ldots\ldots\ldots\ldots+\alpha_p Y_{t-p} + \mu_t$----------(1)

MA (q) is moving average process. It is simply a linear combination of white noise error terms.

MA (q); $Y_t = \alpha_0 - \beta_1 \mu_{t-1} - \beta_2 \mu_{t-2} - \ldots\ldots\ldots\beta_q \mu_{t-q} + \mu_t$ ------- (2)

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

$Yt = \alpha_0+\alpha_1 Y_{t-1} + \alpha_2 Y_{t-2}\ldots\ldots\ldots\ldots+\alpha_p Y_{t-p} - \beta_1 \mu_{t-1} - \beta_2 \mu_{t-2} - \ldots\ldots\ldots\beta_q \mu_{t-q} + \mu_t$

RESULTS AND DISCUSSIONS

ARIMA model was build after testing the data has normality or not. From the Fig1; Q-Q plot shows normality. In the next step identification of ARIMA model is based on past 46values of Ragi production data (1966-2012) used for this model. Various methods and literature studied to judge the appropriate model; the data was alienated into 70% and 30% of total production data of Ragi. The first 70 percent of data is considering as training model and rest of 30 percent data is considering as validation model. The best model has been selected based on the minimum Bayesian Information Criterion (BIC) and minimum Absolute Percentage Error (MAPE). It has been found that ARIMA (2 1 2) model is the best fit for the Ragi production data both training and validation model (Table 1).

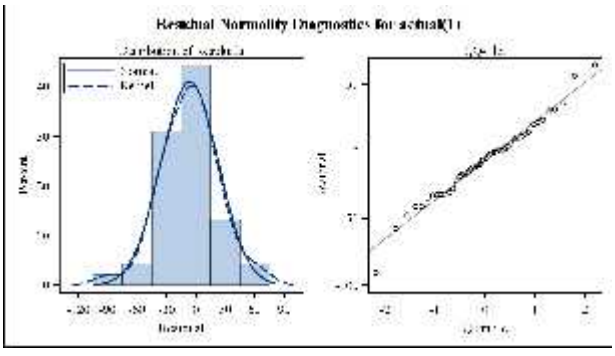

Figure1 Normality test for production data

Table 1 Comparison of Fitting and validation models of ARIMA

Training data (n = 32)				Validation data(n=14)			
Model(p d q)	R-Square	MAPE (%)	BIC	Model(p d q)	R-Square	MAPE (%)	BIC
(1,0,0)	0.700	13.927	7.458	(1,0,0)	0.578	17.803	6.211
(1,1,0)	0.738	12.550	7.355	(1,1,0)	0.810	10.968	5.306
(1,1,1)	0.738	12.546	7.501	(1,1,1)	0.892	7.806	5.036
(2,1,0)	0.738	12.548	7.501	(2,1,0)	0.870	9.916	5.219
(2,1,1)	0.747	12.175	7.614	(2,1,1)	0.912	7.232	5.129
(2,1,2)	0.762	11.940	7.702	(2,1,2)	0.923	6.146	5.310
(2,2,1)	0.713	13.483	7.773	(2,2,1)	0.734	12.576	6.233
(2,2,2)	0.723	13.616	7.889	(2,2,2)	0.760	11.066	6.468

We compare training data model for ARIMA (2 1 2) the R-square and MAPE was 0.76 and 11.94% respectively. In Validation model also it should be high R-square 0.92 and MAPE was 5.31%, it means when we build both model it has been good prediction model (Table:1)

The forecasting results are presented in (Figure:2). The 95% confidence interval regarding forecasting capability of the model is goodness of fit because the actual production values are near to the expected values. The future production of Ragi in Andhra Pradesh by 2018 were calculated and presented in Table 3. The production of Ragi by 2018 would be 41.98 thousand tones. The production of Ragi would be slightly increasing by 2018.the generalization of the autoregressive model and moving average process was expressed in Table 3.

Table 2 Model parameters of ARIMA (2 1 2)

	ARIMA model (2 1 2)		
	Estimate	Standard Error (SE)	p-value
Constant	-5.804	1.169	0.000**
AR1	-0.148	0.238	0.536
AR2	0.712	0.174	0.000**
MA1	0.209	76.977	0.998
MA2	0.791	60.845	0.990

The Overall model R-Square was 0.93
Note: ** Significant at 0.01 levels

Table 3 Actual and predicted Ragi (Kg. /Hectare) in Andhra Pradesh

Years	Actual	Predicted	95% (LCL)	95%(UCL)
2005	87.00	98.47	37.87	159.06
2006	79.00	89.77	29.17	150.36
2007	64.00	80.99	20.40	141.59
2008	69.00	68.63	8.03	129.22
2009	52.00	67.40	6.81	128.00
2010	53.00	57.85	-2.75	118.44
2011	50.00	51.40	-9.20	111.99
2012	40.00	52.73	-7.87	113.32
2013		41.35	-19.25	101.95
2014		42.05	-32.73	116.84
2015		41.57	-48.31	131.46
2016		42.02	-57.95	141.98
2017		41.62	-69.79	153.02
2018		41.98	-77.91	161.86

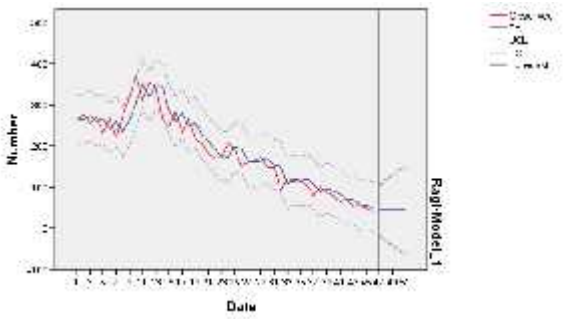

Figure2 Trend and forecasted values of Ragi (Kg. /Hectare) production

CONCLUSION

In this study we provided forecasts of the Ragi production of Andhra Pradesh for the period 2013 to 2018. The ARIMA model for forecast the production of Ragi (Kg. /Hectare) on yearly basis.This model is very useful for prediction of Ragi production for future trends. The forecasted values and observed values are very close each other. The coefficient of determination of overall mode was 90.3%, Bayesian Information Criterion (BIC) was7.28% and Maximum Absolute Percentage Error (MAPE) was 12.06%. These

projections helps the government sectors to make polices with regards to relative price structure, production trend patterns

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