Time Series Forecasting on Onion Production in Tamil Nadu using Appropriate Statistical Models

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Abstract

A study on forecasting of production of onion crops in Tamil Nadu has been undertaken to fit different trend equations like linear, non-linear and time series models also made the future forecasts by 2023 AD. The study crops in all the districts of Tamil Nadu state as a whole using time series data from 1970-1971 to 2019-2020. For forecasting purpose linear and non-linear growth models *viz*., linear, logarithmic, inverse, quadratic, cubic, power, s-curve, logistic and exponential and time series models like ARIMA models were fitted to the onion production in Tamil Nadu. The best fitted model for future projection was chosen based upon least RMSE, R^2 and MAPE values. ARIMA model was identified as the best model for onion production. It was observed that in Tamil Nadu, onion production showed decreasing trend by 2023 AD.

Introduction

Onion (*Allium cepa*) is one of the second most important commercial crops of the India. India is the second largest onion growing country in the world. Indian onions are famous for their pungency and are available round the year. The major Onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Rajasthan, Bihar, Andhra Pradesh, Haryana, West Bengal, Uttar Pradesh, Chhattisgarh, Odisha, Tamil Nadu, Jharkhand and Telangana in the country. Onion is mainly cultivated in Perambalur, Tiruchi, Namakkal, Tiruppur, Erode, Coimbatore and Dindigul districts. The study was confined to onion crops of whole Tamil Nadu. The onion - ubiquitous in Indian cooking and is widely seen as the poor man's vegetable, has the power to change electoral results. There exists significant information asymmetry between market participants leading to poor price discovery in the value chain, which often results in economic losses for the farmers (Kumar *et al.*, 2020). Auto-Regressive Integrated Moving Average (ARIMA) models (Box *et al.*, 1994) have been appreciated for crop yield or any other agricultural production forecasting.

Materials and Methods

The analysis of the data has been carried out by using secondary data available from the publications of Directorate of Economics and Statistics, Indiastat.com, DistrictsofIndia.com, and Seasonal Crop Report (1970-71 to 2019-2020) for whole Tamil Nadu and is based on 50 years of the data from 1970-71 to 2019-2020. The trend equations were fitted by using different linear, non-linear models and time series models for identifying the trend. They are very good in many situations for describing the growth pattern and

the future movement of a time series (Pindyck and Rubinfeld, 1991) these models are widely used to estimate the growth rate of time series data.

Results and Discussion

In the present study, linear, non-linear models *viz*., linear, logarithmic, inverse, quadratic, cubic, compound, S-curve, growth, power and exponential models have been fitted

where as time series models include Auto Regressive (AR), Moving Average (MA) and Auto Regressive Integrated Moving Average (ARIMA) has been fitted to the data on onion production in Tamil Nadu by considering 50 years data from 1970-71 to 2019-20. The results obtained for onion production in Tamil Nadu by fitting all the linear, non-linear and time series models were presented in Table 1.

From Table 1, it was found that all the models fitted well

Table 1: Linear, Non-linear and Time Series Models of Onion Production in Tamil Nadu

Model	Parameter				Criteria		
	a	b	c	d	Adjusted R^2	RMSE	MAPE
Linear	183988.54**	2083.09**			0.34	42324.86	15.29
Logarithmic	155118.394**	27609.91**			0.22	45873.99	16.65
Inverse	243758.02**	-73907.21			0.05	50613.66	17.77
Quadratic	197856.29**	482.97	31.38		0.35	41919.95	15.05
Cubic	207295.04**	-1633.82	134.11	-1.34	0.35	41800.39	14.87
S	12.38**	-0.31			0.05	50736.84	29.19
Exponential	185809.46**	0.01**			0.34	42307.07	14.96
Time Series Models							
ARIMA (1,1,1)					0.31	43564	15.82
ARIMA (3,1,1)					0.35	42352	15.11
ARIMA (1,1,18)					0.44	39148	14.07

*5% level of Significance; **1% level of Significance

Table 2: Forecasted values of Onion Production in Tamil Nadu

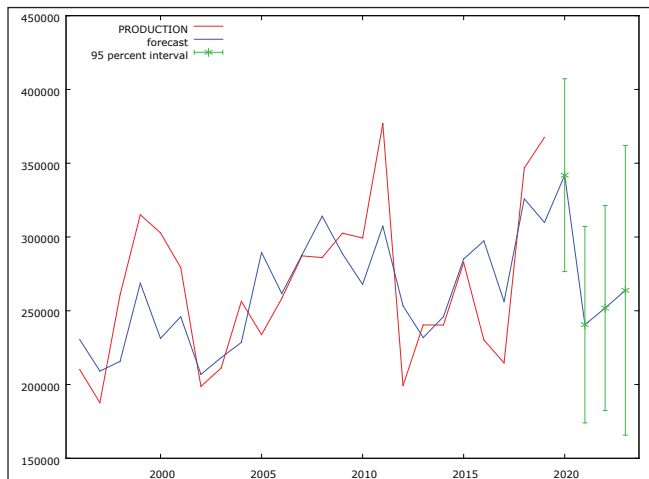| Year	Prediction	Std. error
2020	341909.55	33339.41
2021	240591.27	33970.73
2022	251807.35	35464.08
2023	263823.27	50085.08

Figure 1: Forecasting onion production using ARIMA (1,1,18)

showing significant adjusted R^2 values. In comparison with all other models, ARIMA (1,1,18) was with significant adjusted R^2 (44%) and the low MAPE (14.07) values. Hence, the ARIMA (1,1,18) model was chosen for future forecasts of onion production in Tamil Nadu.

From the Table 2, by using ARIMA (1,1,18) model, the forecasted production would be 2,63,823.27 tonnes by 2023 AD. The forecasted values of production showed a decreasing trend by 2023 AD from the average of study period.

Conclusion

In conclusion the based on the least RMSE and MAPE value, among all the linear, non-linear and time series models for Onion production ARIMA (1,1,18) model was best fitted model for Tamil Nadu. It is observed the future forecasts for onion production in Tamil Nadu during the study period was worked out using the best fitted ARIMA (1,1,18) model. It was observed that the forecasted production would be 263823.27 tonnes by 2023 AD and showing a decreasing trend in onion production.

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