

Pursuance the Price of Green Gram Crop

Using Box-Jenkin's Methodology

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Abstract

Statistical Modeling of non-linear statistics has become a large amount of challenge in the combined field of the research analysis. A number of popularly used models square measure ARIMA and ANN. This text presents a comparison of Artificial Neural Network (ANN) and BoxJenkins methodology for predicting the true price of Greengram crop worth in the state of Telangana. The most important objective of this analysis is to develop a forecasting model to predict the price of the Greengram crop with high accuracy and efficiency. During this paper, a statistic forecasting model Box- Jenkins methodology and Artificial Neural Networks was developed for forecasting the yearly price of the Greengram crop in Telangana. The forecasting performance of the model was evaluated accuracy of Root mean squared error (RMSE), Mean Absolute percent Error (MAPE). The yearly forecasts counsel that, the price of Greengram crop with a regular deviation of 12% error measure with the accuracy of 94% for the forecasted period of 12 months i.e. 2020-2022 (since Covid period of time).

KEY WORDS: ARIMA, Box-Jenkins Methodology, ANN, MAE, RMSE and MAPE

I.INTRODUCTION

A statistic is the basic object of the study in varied sectors of analysis. Conventionally statistic modelling includes an underlying assumption that there's a linear underlying relationship between the past and future values of the series.

Agriculture is known to be the spine of the Indian Economy for the last many decades for any kind of growth and price of all the crops. Greengram is cultivated in Two lakhs hectares across the Telangana region making it one of the major crops of the state. It is widely price grown in Mahbubnagar, Warangal, Nalgonda, and Karimnagar Districts. Crop price rotation is crucial in Greengram farming, this helps to utilize nutrients efficiently and to reduce soil-borne diseases. Greengram is more beneficial to human nutrition, and is an important product since it is used in the prices of many foods and ranked second among seed plants after cotton, chilli, soyabean, and sugarcane. Greengram also has a particular economic value since its grams, kernels, shell, and straw can be used commercially as well as extensively throughout the state of Telangana. The prices of the Greengram for Telangana and based on the Indian harvested area. Increasing prices would also be an

important tool in the development of rural areas of the state by increasing the growth of revenues. Thus, it is important for Telangana to formulate schemes aiming at increasing Greengram price for the future sustainability of all the industry, export revenues, and food safety. An effort is made during this paper to assess the yearly prices of the Greengram crop in the state of Telangana and to forecast the same for a brief tenure by victimization applied mathematics strategies. The subsequent section presents the results that supported the Box-Jenkins methodology and artificial neural networks.

II. ARIMA (Auto Regressive Integrated Moving Average) MODEL USING BOX-JENKINS METHODOLOGY

During this section, the modelling of Greengram prices of Telangana State Box-Jenkins methodology is mentioned. The Box-Jenkins procedure relates to the fitting of the associate ARIMA model of the subsequent type for the given set of information and therefore the general kind of ARIMA (p, d, q) model is given by

$$\Phi(B)\nabla^d Z_t = \theta(B)a_t$$

$$\text{Where } \Phi(B) = 1 - \Phi_1 B - \Phi_2 B^2 - \dots - \Phi_p B^p$$

$$\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - \dots - \theta_q B^q$$

$$\text{And } \nabla^d = (1 - B)^d$$

We have $B^k Z_t = Z_{t-k}$ and a_t is a white noise process with zero mean and variance σ^2 . The

Box-Jenkins procedure consists of the subsequent four stages. (1) Model Identification, wherever the orders d, p, and q are determined by perceptive the behaviour of the corresponding Autocorrelation function (ACF) and Partial Autocorrelation Function (PACF). (2) Estimation: wherever the parameters of the model are a unit calculable by the most probability methodology. (3) Diagnostic checking by the “Portmanteau Test”, where the adequacy of the fitted model is checked by the Ljung-Box datum, applied to the residual of the model. (4) Forecasts area unit obtained from associate degree adequate model victimization minimum mean square error methodology. If the model is judged to be inadequate, stages 1-3 area unit perennial with completely different values of d, p, and q, till associate the adequate model is obtained (Box et al; 1994).

III. ANN (Artificial Neural Network) MODEL

An Artificial Neural Network could be a mathematical model that is impressed by the structure and useful aspects of the biological neural network, a powerful predictive model. Associate degree ANN will estimate any nonlinear continuous function up to any desired degree of accuracy. It is widely used in a range of industries, business engineering, and sciences. It has the power to perfectly predict the longer term and is prime to several call processes in designing, scheduling, purchasing, strategy formulation, policy-making, and providing chain operations.

The characteristics of ANN that build it applicable for predictions are its non-linear structure, flexibility, knowledge-driven learning method, and its ability to estimate method universal functions. Neural networks area units precisely shown to possess the universal sensible approximating potential during which they will accurately approximate several varieties of advanced sensible relationships. This can be a very important and powerful characteristic, as any prediction model aims to accurately capture the useful relationship between the variable to be foreseen and different relevant factors or

variables. The mixture of the abovementioned characteristics makes ANN a really general and versatile modelling tool for prediction. Finally, ANNs are unit non-linear models. The very fact that globe systems are unit typically non-linear has led to the event of many non-linear statistical models in the last decade. (Hornik,1993; Ramakrishna et al., 2011).

IV. FORECASTING PRICES OF GREENGRAM CROP USING BOX-JENKINS METHODOLOGY

In this paper, the building of prediction models victimization Box-Jenkins methodology for the yearly price of Greengramcrop is mentioned.

The data on the yearly prices of Greengram were collected from the year 2019 (Jan-Dec) from the Directorate of Economics and Statistics (DAES). The yearly prices of Greengram crops from 2019 Jan to August was used for model building and therefore the yearly Greengram crop prices from 2019 August to Decemberwas used for model validation. The prediction models for the prediction of the yearly prices of Greengram crops were developed victimization Box-Jenkins methodology and Artificial Neural Networks. The yearly prices of the Greengram crop varied with an average price of 3500 Rs. The subsequent chart shows the time trend of the yearly prices of the Greengram crop from 2019 (Jan-Dec). The yearly prices of the Greengram crop show a non-stationary time series (**Fig 1**). The average Greengram prices was comparatively low in the year 2019 Jan high in 2019 Oct due to the low and high rain fall during the above years (**Fig 1**). Also shown one of the outliers in the figure to be out of confusion about the prices of response variable.

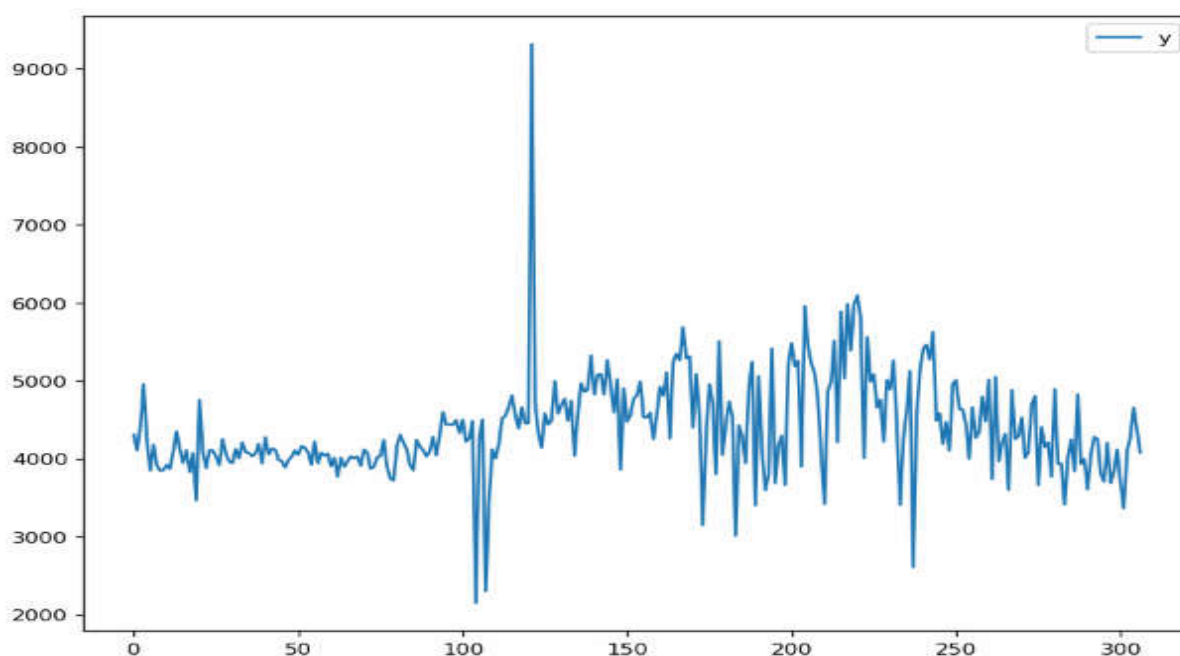


Fig1: The yearly average for the prices of the Greengram Crop (in Rs)

The python skilled creator was accustomed to determining the most effective ARIMA model for the prices of Greengram, as this plan automatically determines and estimates the best-fitting ARIMA for one or additional variable series, therefore eliminating the necessity to spot an applicable model

through the trial-and-error methodology. It is discovered that the ARIMA (0, 1, 1) model fits the data well as compared with another outcome ARIMA(0,1,0) and therefore the same is tested on the validation set with the original series and orderwise differencing for ACF and PACF. The model parameters square measure is given in the following Table 1 and Table 2

A.Original Series, Differencing, and ACF (Auto Correlation Function)

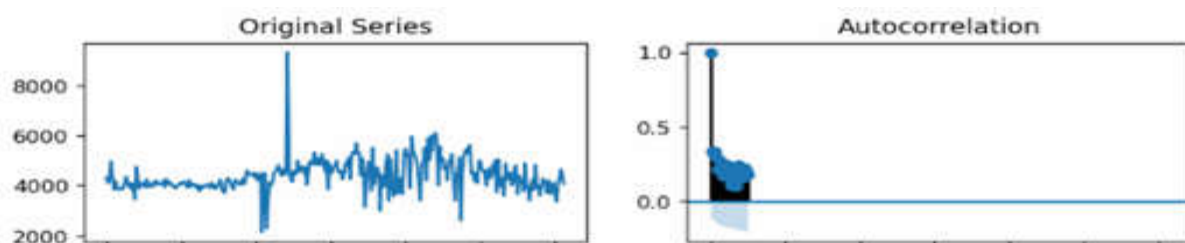


Fig2: Time series of Greengram Prices in Telangana Original Series with ACF

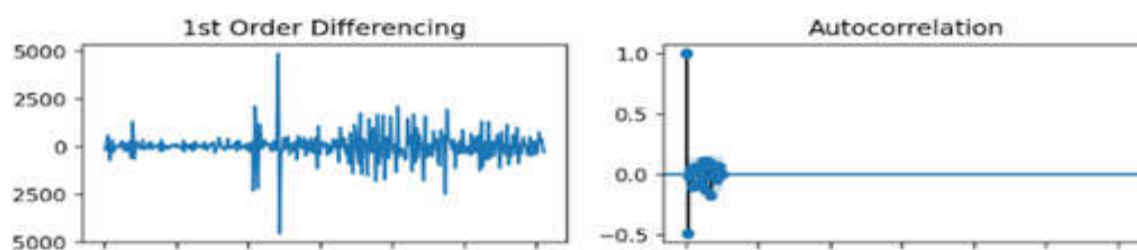


Fig3: Time series of Greengram prices in Telangana 1st Order differencing with ACF

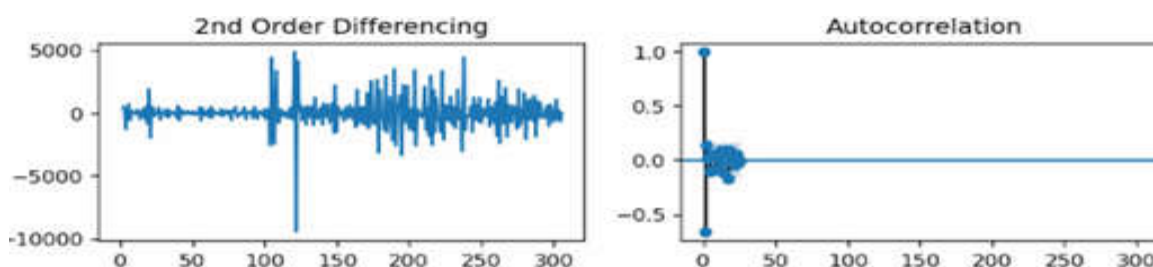


Fig4: Time series of Greengram prices in Telangana 2nd Order differencing with ACF

B. Original Series, Differencing, and PACF (Partial Auto Correlation Function)

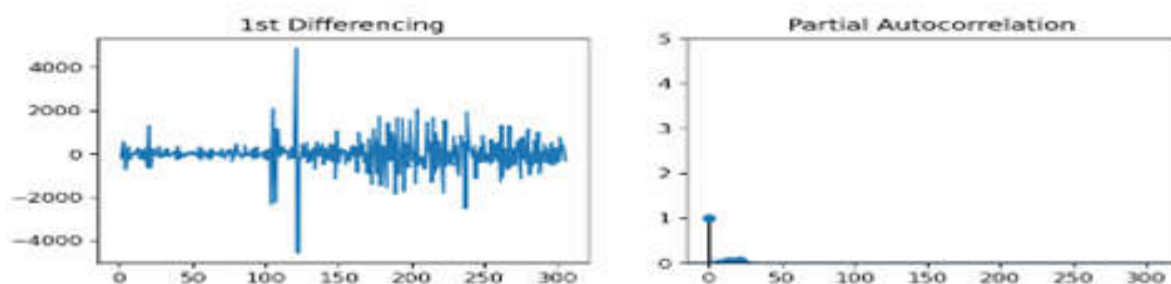


Fig5: Time series of Greengram prices in Telangana, 1st Order differencing with PACF

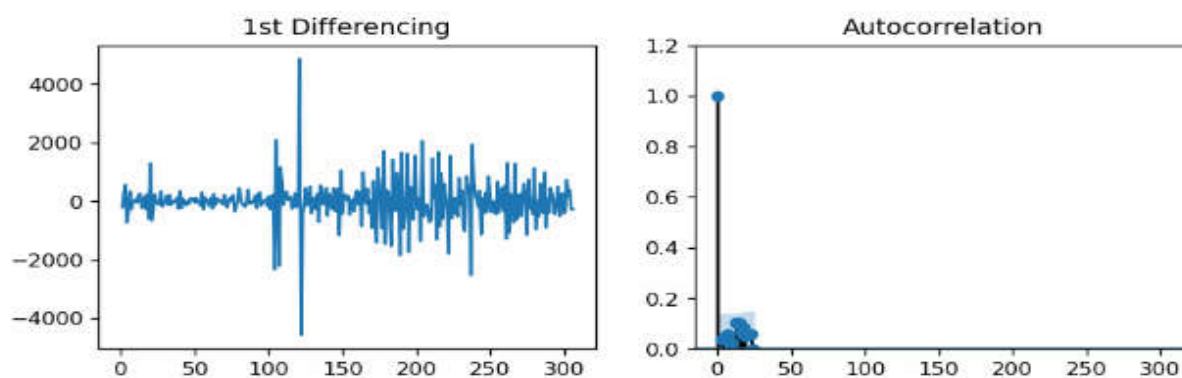


Fig6: Time series of Greengram prices in Telangana 1st Order differencing with ACF

Table 1. ARIMA Model Parameters

ARIMA Model Results					
Dep. Variable:	D.y	No. Observations:	306		
Model:	ARIMA(0, 1, 0)	Log Likelihood	-2456.191		
Method:	css	S.D. of innovations	740.874		
Date:	Fri, 05 Aug 2022	AIC	4916.382		
Time:	07:57:19	BIC	4923.830		
Sample:	1	HQIC	4919.361		

	coef	std err	z	P> z	[0.025	0.975]
const	-0.7487	42.353	-0.018	0.986	-83.759	82.262

ARIMA Model Results					
Dep. Variable:	D.y	No. Observations:	306		
Model:	ARIMA(0, 1, 1)	Log Likelihood	-2376.819		
Method:	css+mle	S.D. of innovations	570.344		
Date:	Fri, 05 Aug 2022	AIC	4759.638		
Time:	07:57:41	BIC	4770.809		
Sample:	1	HQIC	4764.106		

	coef	std err	z	P> z	[0.025	0.975]
const	-0.3406	1.648	-0.073	0.941	-9.436	8.754
ma.L1.D.y	-0.8606	0.038	-22.437	0.000	-0.936	-0.785
Roots						
	Real	Imaginary	Modulus	Frequency		
MA.1	1.1620	+0.0000j	1.1620	0.0000		

Hence, the fitted model for the forecasting of Greengram price in the state of Telangana is ARIMA (0,1,0) and ARIMA (0,1,1) $\nabla Z_t = (1 + 0.052B - 0.119B)at$.

The adequacy of the model was checked by exploitation Ljung-Box q test statistic and therefore the same is discovered that $Q=13.673$ at 20 degrees of freedom. The corresponding p-value of the letter check datum is 0.67 and which is far larger than 0.05, hence, the null hypothesis of the adequate model was accepted and therefore the given ARIMA (0,1,1) model may be an appropriate model for

the prediction of the prices of Greengram. Similarly, a synthetic neural networks model was developed for the prediction of the prices of Greengram using python.

V. FEED FORWARD NEURAL NETWORK USING ANN

ANN (Artificial Neural Network) model may be a feed-forward neural networks model having one input layer, one hidden layer Associate in Nursing, and an output layer. The standardized values of previous observation (Lag-1 or $Z_t - 1$) were used as Associate in nursing input for the one-step a head prediction for the yearly prices of Greengram crop during this ANN model. The hidden layer consists of two hidden neurons to capture the nonlinearity element within the statistic. The hyperbolic tangent function is employed as an activation function in the hidden layer and the identity is used as an activation function in the output layer. The subsequent Figure 6 shows a typical feed-forward neural network used for the prediction of Greengram price in Telangana state. The ANN model was trained exploitation back propagation rule until the error measures of the testing sample are smaller than the coaching sample on a trial-and-error basis.

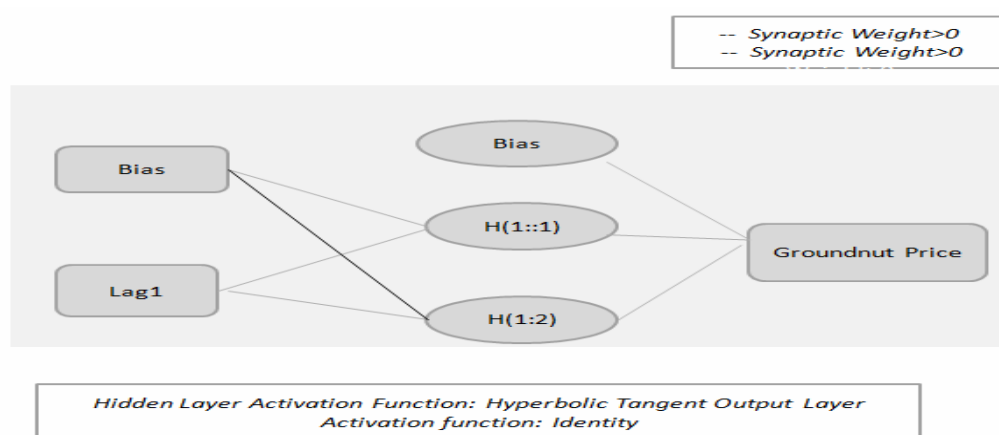


Fig7: Feed forward neural network prediction model for the yearly price of Greengram crop.

Table 2. Feed forward Neural Networks Model Parameters

Predictor		Predicted		
		Hidden Layer 1		Output Layer
		H(1:1)	H(1:2)	S_t
Input Layer	(Bias)	0.021	-0.052	
	lag1	0.152	0.267	
Hidden Layer 1	(Bias)			0.119
	H(1:1)			2.213
	H(1:2)			3.104

Hence the ANN Model is here.

$$L = (Z_{t-1} - 32301.15) / 3313.543; h_1 = \tanh(0.021 + 0.152 * L); h_2 = \tanh(-0.052 + 0.267 * L);$$

$$S_t = 0.119 + 2.213 * h_1 + 3.104 * h_2 \text{ and } Z_t = 32301.52 + 3313.543 * S_t$$

VI. COMPARISON OF ARIMA AND ANN MODELS ON ERROR MEASURES

The predictions from the two models were compared in the training sample and testing samples supported the mean absolute error, root means square error and mean absolute percentage errors. The subsequent Table 3 presents the error measures from the ARIMA and ANN prediction models.

Table 3. Comparison of the forecasting performance of ARIMA and ANN models

Measure	Training Sample		Testing Sample	
	ARIMA	ANN	ARIMA	ANN
MAE	313.23	332.31	457.77	455.45
RMSE	529.03	521.11	526.67	524.26
MAPE	0.15	0.13	0.18	0.21

The ANN model has comparatively lower error measures in the testing sample as compared to the ARIMA Model. The ANN fits well stronger than ARIMA within the training and testing samples not show stronger performance in the testing sample. The following figure 7 shows the out-of-sample forecasts supported by ARIMA and ANN models. The ANN model forecasts show a similar trend to the original costs, whereas the ARIMA forecasts show a linear trend over time.

Table 4. Out-of-sample forecasts of Greengram prices in Telangana state using ARIMA and ANN Models

Greengram Prices in Telangana State Using ARIMA and ANN Models for the 2020 monthly prices

Year - Month	(Rs.)	ARIMA	ANN
2020 - Jan	5984	5999	6011
2020 - Feb	6845	6860	6872
2020 - Mar	9548	9563	9575
2020 - Apr	9684	9699	9711
2020 - May	9885	9900	9912
2020 - Jun	8957	8972	8984
2020 - Jul	8996	9011	9023
2020 - Aug	9487	9502	9514
2020 - Sep	9584	9599	9611
2020 - Oct	9984	9999	10011
2020 - Nov	10522	10537	10549
2020 - Dec	13254	13269	13281

Mean	9394.17	9409.17	9421.17
SD	1793.64	1793.64	1793.64

VII. CONCLUSION

The forecasts recommend that the ANN model predicts well the Greengram prices in Telangana State as compared to the ARIMA model. ARIMA model provides only linear trends whereas the ANN model presents the nonlinear fluctuations within the forecasts.

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