Forecasting Area, Yield and Production of Groundnut Crop: A Comparative Study of Coastal Andhra and Ceded Regions Using- R

Ananda Kumar Ginka, Dhanunjaya Sunkara, Mohammed Akhtar

Abstract— This comparative study has been carried out to discuss all investors are excited to know about the trend of groundnut area, yield and production in Coastal Andhra and Ceded Regions (Seemandhra). Now it has 13 districts during 2003-2004 to 2018 (15 years of data) for present comparative analysis of groundnut crop production in Coastal Andhra and Ceded were collected and presented. Based on results collected some conclusions are made about the forecast production of groundnut crop by using ARIMA with R-software.

Index Terms— Area, yield, production, Groundnut, ARIMA, R software.

I. INTRODUCTION

Time is one of the most important factors on which our business and real-life dependent situations. But now a day's technology has helped us manage the time with continuous innovations taking place in all aspects of our lives. Time series modelling is a dynamic research area which has attracted the attention of researcher's community over last few decades. This model is used to generate future values for the series, i.e to make forecasts. Forecasting lays a ground for reducing the risk in all decision making because many of decisions need to be made under uncertainty.

India is an agricultural country. The Economic progress and standard of living of people directly or indirectly is determined by agriculture. Indian economy mainly depends on agriculture as majority of the population depends on agricultural and allied activities for seeking out their livelihood. Groundnut is grown throughout the tropics and its cultivation is extended to the subtropical countries lying between 45° North and 35° South and up to an altitude of 1,000 meters. The total amount of rainfall required for presuming operations (preparatory) is 100 mm, for sowing it is 150 mm and for flowering and pod development an evenly distributed rainfall of 400-500 mm is required, Madhusudana ,*B et al*(2013)[1]. Coastal Andhra is located in the eastern region of the state of Andhrapradesh on Coromandel Coast and comprises nine districts. In Andhra Pradesh groundnut is grown majorly in Srikakulam and Vishakapatnam districts of Coastal Andhra Region.

Ceded Districts is name of an area in the Deccan, India that was 'Ceded' to the British East India Company by the Nizam in 1800. The name was the British Raj, even though the denomination had no official weight for legal or administrative purposes. Rayalaseema, meaning 'rocky region', Especially, groundnut is the only important commercial crop in the drought prone district of Anantapuramu in Rayalaseema region of Andhra Pradesh. So, the district headquarter of Anantapuramu is called as 'Groundnut City'. Groundnut is an important protein supplement for cattle and poultry rations. It is also consumed as confectionery product. The cake can be used for manufacturing artificial fibre. The haulms are fed to livestock.

Crop area estimation and forecasting of crop yield are an essential procedure in supporting policy decision regarding land use allocation, food security and environmental issues. Statistical techniques able to provide crop forecast with reasonable precessions well in advanced. Various approaches have been used for forecasting such agricultural systems. Concentration have been given on the uni-variate time series Auto Regressive Integrated Moving Average (ARIMA) MODELS, which are primarily due to World of Box and Jenkins (1970). Among the stochastic time series models ARIMA types are powerful and popular as they can successfully describe the observed data and can make forecast with minimum forecast error. These types of models are very difficult to identify and estimate.

II. LITERATURE REVIEW

Muhammad Iqbal Ch et al.(2016) for forecasting of wheat production: A comparative study of Pakistan and India [2], Similar studies have been done by Rachana et al. (2010) for forecasting pigeon pea production in India by using ARIMA Modelling [3], N.M.F. Rahman et al. (2010)for forecasting of Boro rice production in Bangladesh [4], Najeeb Iqbal et al. (2005) for forecasting wheat area and production in Pakistan [5], M.K Debnath et al. (2013)for forecasting Area, production, and Yield of Cotton in India using ARIMA Model [6], M. Hemavathi et al.(2018) ARIMA Model for Forecasting of Area, Production and productivity of Rice and Its Growth Status in Thanjavur District of TamilNadu, India[7], P.K. Sahu et al.(2015) for modelling and forecasting of area, production, yield and total

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seeds of Rice and Wheat in SAARC Countries and the World towards Food Security[8], Mohammed Amir Hamjah et al.(2014) for Rice Production Forecasting in Bangladesh: An Application of Box-Jenkins ARIMA Model[9], Muhammad et al(1992) conducted an empirical study of modelling and forecasting time series data of rice production in Pakistan [10], Niaz Md. Farhat Rahman et al.(2013), Modelling for Growth and Forecasting of pulse production in Bangladesh [11], Vishwajith K..P et al.(2014), Timeseries Modeling and forecasting of pulses production in India[12], Ashwin Darekar et al.(2017), Forecasting oilseeds prices in India: Case of Groundnut [13] , Bhola Nath et al.(2018) DS , Forecasting Wheat production in India: An ARIMA modelling approach [14] , Pant, D.C. and Pradeep Pal, et al.(2004), Comparative Economics of Agro-processing units for Groundnut in Southern Rajasthan [15], Ap Patel, G.N., and N.L. Agarwal et al. (1993), Price Behaviour of Groundnut in Gujarat [16], Mohammad Mayazzem Hossain(2017), Comparision of ARIMA and Neural Net Work Model to forecast the jute Production in Bangladesh, Jahingir Nagar University Journal of Science, [17] , also use the ARIMA Model . The study is to identify the best ARIMA model, which is for fitting and forecasting of Groundnut Area, Yield, Production in Ceded region respectively. Conclusions are drawn and found the forecasting for the future. The R-Software is used to analyse and graphical representation of the results.

R- software: R is a commonly used free Statistics software. R allows you to carry out statistical analyses in an interactive mode, as well as allowing simple programming. The R-language is widely used among statistician and data miners for developing statistical software and data analysis. Although R has a command line interface, there are several graphical user interfaces, such as R studio, an integrated development environment. R is a programming language and environment commonly used in statistical computing, data analytics and scientific research. It is one of the most popular languages used by statisticians, data analysts, researchers and marketers to retrieve, clean, analyze, visualize and present data.

III. MATERIALS AND METHODS

A. Data collection:

The study has utilized secondary source of data. The time series data on yearly kharif and Rabi seasons totals area, yield and production of groundnut crop from 2003-2004 to 2017-2018 of 15 years data required for the study was collected from the DIRECTORATE OF ECONOMICS AND STATISTICS, HYDERABAD. The 15 years of comparative data of groundnut producing ceded districts viz., Anantapuramu, Kurnool, cuddapah, chittoor districts of Andhra Pradesh and Coastal Andhra Andhra districts viz., Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari,Krishna, Guntur, Prakasam, and Nellore districts. Coastal Andhra borders Rayalaseema regions of the state and the states of Telangana, Odisha. The presence of the Krishna River Godavari River and Penna River makes the area fertile for irrigation.

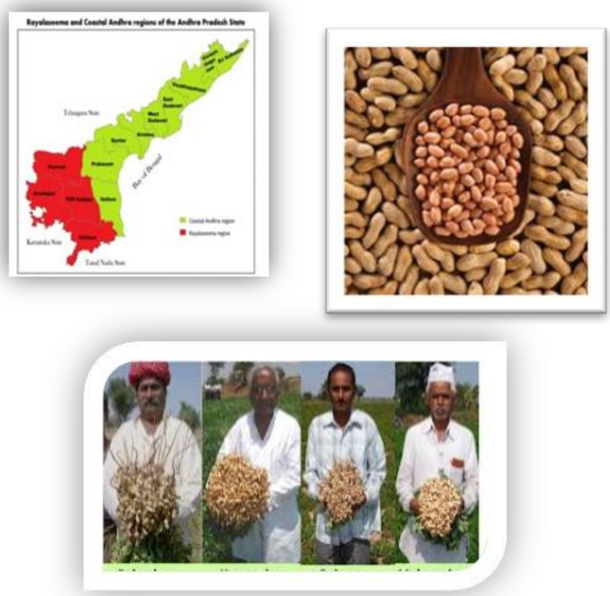

Fig:1 Area, Yield and Production of Groundnut Crop in Ceded and Coastal Andhra Regions

B. Auto Regressive Integrated Moving Average (ARIMA) model (Box-Jenkins model):

One of the most popular and frequently used stochastic time series models is the Auto Regressive Integrated Moving Average (ARIMA) model was introduced by Box and Jenkins. The basic assumption made to implement this model is that considered time series is linear and follows a particular known statistical distribution, such as the Normal Distribution. ARIMA model has subclasses of other models, such as Auto Regressive (AR), Moving Average (MA) and Auto Regressive Moving Average (ARMA) models. For seasonal time series forecasting, Box and Jenkins had proposed a quite successful variation of ARIMA model, viz. the Seasonal ARIMA (SARIMA). The popularity of the ARIMA model is mainly is due to its flexibility to represent several varieties of time series with simplicity as well as the associated Box-Jenkins(1994) [5] methodology for the optimal model building process.

The term ARIMA stands for "Auto-Regressive Integrated Moving Average." Lags of the differenced series appearing in the forecasting equation are called "auto-regressive" terms, lags of the forecast errors are called "moving average" terms, and a time series which needs to be differenced to be made stationary is said to be an "integrated" version of a stationary series. Random-walk and random-trend models, autoregressive models, and exponential smoothing models (i.e., exponential weighted moving averages) are all special cases of ARIMA models. A non-seasonal ARIMA model is classified as an "ARIMA (p, d, q)" model, where p is the number of autoregressive terms, d is the number of non-seasonal differences, and q is the number of lagged forecast errors in the prediction equation. The Box-Jenkins methodology seeks to transform any time series data to be stationary; and then apply the stationary process for

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forecasting by using past uni-variate time series process for future forecast with a host of selection and diagnostic tools.

1) Model Identification

This stage involves the specification of the correct order of ARIMA model by determining the appropriate order of the AR, MA and the integrated parts or the differencing order. The major tools in the identification process are the (sample) autocorrelation function and partial autocorrelation function. The identification approach is basically designed for both stationary and non-stationary processes. Spikes represent in the line at various lags in the plot with length equal to magnitude of autocorrelations and these spikes distinguish the identification of a stationary and non-stationary process. The main objective in fitting ARIMA model is to identify the stochastic process of the time series and its stationarity counterpart. The main objective in fitting ARIMA models is to identify the stochastic process of the time series and predict the future values accurately. Ansari and Ahmad (2001)[18] worked with application of ARIMA modelling and co-integration analysis on time series of tea price. Different stages in forecasting model are given below. Identification: A good starting point for time series analysis is a graphical plot of the data. It helps to identify the presence of trends. Before estimating the parameters p and q of the model, the data are not examined to decide about the model which best explains the data. This is done by examining the sample ACF, and PACF. Both ACF and PACF are used as the aid in the identification of appropriate models. There are several ways of determining the order type of process, but still there was no exact procedure for identifying the model.

2) Model Estimating the parameters

After tentatively identifying the suitable model is not "estimating a second time series", it is filtering it. The function accuracy gives multiple measures of accuracy of the model fit, ME(mean error), RMSE(root mean squared error), MAE(mean absolute error), MPE(mean percentage error), MAPE(mean absolute percentage error), MASE(mean absolute scaled error) , And ACF (auto correlation function) It is up to you to decide, based on the accuracy measures, whether you consider this a good fit or not. For example, mean percentage error of nearly -70% does not look good to me in general, but that may depend on what your series are and how much predictability you may realistically expect. It is often a good idea to plot the original series and the fitted values, and also model residuals. You may occasionally learn more from the plot than from the few summarizing measures such as the ones given by the accuracy` function. Depending on the ACF and PACF of these sequence plots a model is run with appropriate software (R-Software). The best fitting model must also have few parameters as much as possible alongside best statistics of the model according to the information selection criteria.

3) Model Diagnostic Checking

After having estimated the parameters of a tentatively identify ARIMA model, it is necessary to do diagnostic checking to verify that the model is adequate. Examining ACF And PACF considered random when all their ACF and PACF considered random when all their ACF were within the limits. Model checking in time series can be done by looking at the residuals. Traditionally the residuals given by Residuals = observed values – fitted values. These results should be normally distributed with zero mean, uncorrelated, and should have minimum variance or dispersion, if indeed a model fits the well. That is model validation usually consist of plotting residuals overtime to verify the validation.

4) Model Forecasting

After satisfying about the adequacy of the fitted model, it can be used for forecasting future values. This was done with the help of R- Software.

IV. RESULT AND DISCUSSIONS

Analysis of Time series data regarding agricultural oriented groundnut crop area, yield and production using R software tabulated along with necessary graphical presentations mentioned below, Groundnut is an important protein supplement for cattle and poultry rations. It is also consumed as confectionery product. The cake can be used for manufacturing artificial fibre. The haulms are fed to live stock. Groundnut shell is used as fuel for manufacturing coarse boards. Cork substitutes. Groundnut is also valued as a rotation crop. Being a legume with root nodules, it can synthesize with atmospheric nitrogen and thereby improve soil fertility. All investors are timely cautious about crop production with updated technology.

Table-1 Area, Yield and Production Of Groundnut Crop In Ceded And Coastal Andhra Regions

	CEDED REGION				COASTAL ANDHRA REGION		
	YEAR	Area (in 000'ha.)	Yield (in Kg/ha.)	Prod. (in 000'tones)	Area (in 000'ha.)	Yield (in Kg/ha.)	Prod. (in 000'tones)
1	2003-2004	1164	2664	603	**134**	**12122**	**159**
2	2004-2005	1511	3455	1267	**136**	**16249**	**175**
3	2005-2006	1554	2800	924	**123**	**18489**	**186**
4	2006-2007	1041	2522	366	**114**	**17059**	**157**
5	2007-2008	1474	6278	2076	**115**	**16221**	**183**
6	2008-2009	1447	1978	471	**118**	**17290**	**188**

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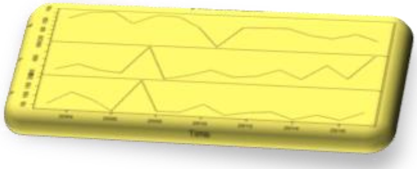
7	2009-2010	991	2588	493	**96**	**18316**	**154**
8	2010-2011	136	3466	962	**91**	**16854**	**143**
9	2011-2012	1058	2681	444	**77**	**18098**	**138**
10	2012-2013	1089	2899	635	**70**	**18794**	**143**
11	2013-2014	1111	3933	739	**42**	**23234**	**106**
12	2014-2015	832	2774	391	**42**	**23278**	**102**
13	2015-2016	732	4785	694	**66**	**20216**	**142**
14	2016-2017	968	3112	485	**46**	**23764**	**117**
15	2017-2018	697	6243	942	**37**	**24519**	**106**
	TOTAL	15805	52178	11492	**1307**	**284503**	**2199**



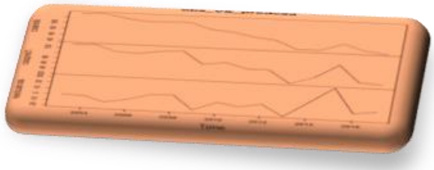


Fig:2 Area, yield, Production of Ceded Region

Fig:3 Area, yield, Production of Coastal andhra Region

ACF, PACF plots are analysed to check stationarity of data upto15 (0 to 14) lags as shown below:

Fig:4 AREA- ACF(CEDED REGION)

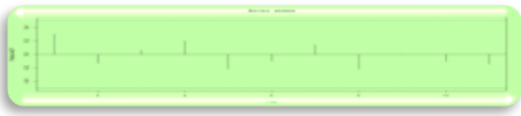


Fig:5 AREA- PACF(CEDED REGION

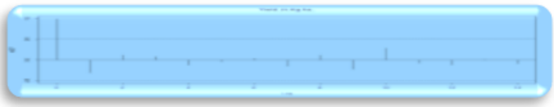


Fig:6 Yield- ACF(CEDED REGION)

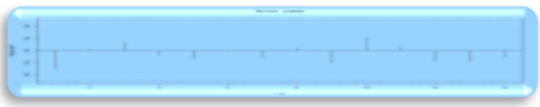


Fig: 7 YIELD - PACF(CEDED REGION)

Fig :8 Production -ACF(CEDED REGION)

Fig:9 PRODUCTION- PACF(CEDED REGION)

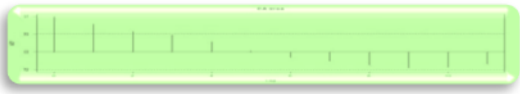


Fig:10 Area-ACF(Coastal Region)

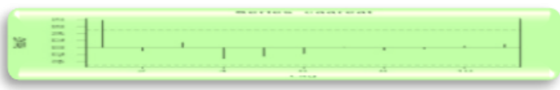


Fig:11Area-PACF(Coastal Region)

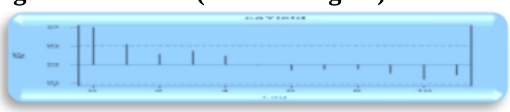


Fig:12 YIELD-ACF(Coastal Region)

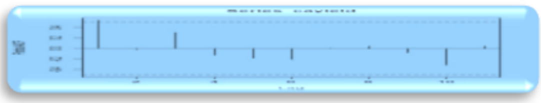


Fig:13 YIELD-ACF(Coastal Region)

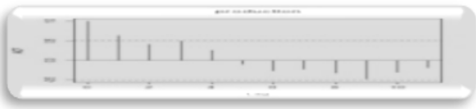


Fig:14 prod-ACF(Coastal Region)

Fig:15 prod-ACF(Coastal Region)

Table-2 Area, Yield And Production ACF And PACF(CEDED REGION & COASTAL ANDHRA REGIO

	Area, Yield and Production ACF and PACF(CEDED REGION)						Area, Yield and Production ACF and PACF(COASTAL REGION)					
Lag	ACF (area)	PACF (area)	ACF (YIELD)	PACF (YIELD)	ACF (PROD)	PACF (PROD)	ACF (AREA)	PACF (AREA)	ACF (YIELD)	PACF (YIELD)	ACF (PRO)	PACF (PROD.)
0	**1.000**	**0**	**1.000**	**0**	**1.000**	**0**	**1.000**	**0**	1.000	**0**	**1.000**	**0**
1	**0.299**	**0.299**	**-0.306**	**-0.306**	**-0.348**	**-0.348**	0.784	0.784	0.546	0.546	**0.634**	**0.634**

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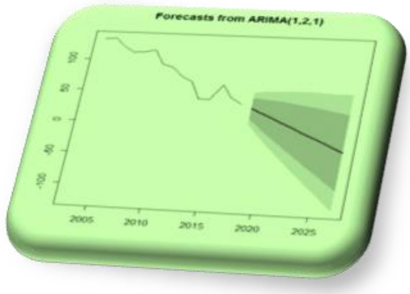
2	**-0.030**	**-0.131**	**0.119**	**0.028**	**-0.037**	**-0.180**	0.578	-0.097	0.287	-0.016	**0.410**	**0.014**
3	0.006	0.062	**0.081**	0.138	**0.449**	**0.437**	0.477	0.148	0.369	0.311	**0.493**	**0.381**
4	**0.205**	0.202	**-0.123**	-0.073	**-0. 318**	**-0.025**	0.287	-0.314	0.242	-0.126	**.256**	**-0.390**
5	**-0.057**	-0.217	**-0.041**	-0.135	**0.023**	**-0.104**	0.038	0.248	-0.008	-0.185	**-0.103**	**-0.355**
6	**-0.201**	-0.100	**0.033**	-0.008	**0.046**	**-0.240**	-0.154	-0.175	-0.143	-0.208	**-0.274**	**-0.437**
7	**0.016**	0.140	**-0.152**	-0.115	**-0.204**	**-0.137**	-0.263	0.008	-0.120	0.007	**-0.228**	**0.280**
8	**-0.051**	-0.221	**0.115**	0.046	**0.027**	**-0.054**	-0.368	-0.077	-0.114	0.045	**-0.331**	**0.078**
9	**-0.130**	-0.002	**-0.228**	-0.206	**-0.161**	**-0.191**	-0.450	0.038	-0.225	-0.077	**-0.480**	**0.108**
10	**-0.209**	-0.104	**0.284**	0.208	**0.054**	**0.047**	-0.432	**0.045**	-0.396	-0.316	**-0.311**	**-0.014**
11	**-0.108**	-0.145	**-0.077**	0.061	**-0.033**	**-0.014**	-0.340	0.099	-0.275	0.048	**-0.189**	**-0.187**
12	**-0.130**	-0.048	**-0.112**	-0.181	**-0.037**	**0.079**	-0.274	-0.044	-0.146	0.042	**-0.208**	**-0.104**
13	**-0.089**	0.001	**0.010**	-0.185	**0.049**	**-0.118**	-0.250	-0.185	-0.288	-0.107	**-0.127**	**-0.066**
14	**-0.020**	-0.030	**-0.094**	-0.113	**-0.010**	**-0.060**	-0.134	0.068	-0.228	0.067	**-0.042**	**-0.145**

Table-3 AREA, YIELD, AND PRODUCTTION POINT FORECAST (CEDED REGION)

Area Point Forecast of Groundnut (CEDED REGION)

Year	Area Point forecast	Lo 80	Hi 80	Lo95	Hi 95
2018	663.6431	74.34483	1252.941	-237.6108	1564.897
2019	630.2862	-230.43900	1491.011	-686.0794	1946.652
2020	596.9294	-489.68298	1683.542	-1064.9008	2258.760
2021	563.5725	-727.51535	1854.660	-1410.9760	2538.121
2022	530.2156	-952.81919	2013.250	-1737.8904	2798.322
2023	496.8587	-1169.92849	2163.646	-2052.2723	3045.990
2024	463.5018	-1381.29353	2308.297	-2357.8692	3284.873
2025	430.1449	-1588.43457	2448.724	-2657.0060	3517.296
2026	396.7881	-1792.35779	2585.934	-2951.2216	3744.798
2027	363.4312	-1993.76182	2720.624	-3241.5844	3968.447

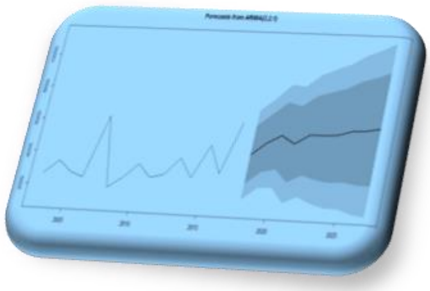
Fig: 16 Area forecast



Yield Point Forecast (CEDED REGION)

Year	Yield point forecast	Lo 80	Hi 80	Lo95	Hi 95
2018	4338.339	2588.741	6087.937	1662.5598	1662.5598
2019	5078.286	3321.278	6835.294	2391.1738	7765.398
2020	5563.951	3536.040	7591.862	2462.5287	8665.374
2021	5098.539	2814.759	7382.319	1605.7985	8591.279
2022	5657.126	3256.581	8057.670	1985.8098	9328.442
2023	5666.277	3015.238	8317.315	1611.8634	9720.690
2024	5738.279	2906.801	8569.757	1407.9071	10068.650
2025	5998.293	2982.656	9013.931	1386.2738	10610.313
2026	6050.198	2823.687	9276.709	1115.6751	10984.720
2027	6216.148	2804.532	9627.765	998.5315	11433.765

Fig:17 Yield forecast



Production Point Forecast (CEDED REGION)

Year	Production Point forecas	Lo 80	Hi 80	Lo95	Hi 95
2018	670.0918	-116.26186	1456.446	-532.5324	1872.716
2019	818.4277	-56.75061	1693.606	-520.0420	2156.898
2020	724.4765	-376.64553	1825.599	-959.5443	2408.497
2021	770.2133	-461.00217	2001.429	-1112.7683	2653.195
2022	735.4144	-663.80745	2134.636	-1404.5108	2875.340
2023	747.0475	-792.33296	2286.428	-1607.2318	3101.327
2024	731.9108	-957.86174	2421.683	-1852.3733	3316.195
2025	732.2079	1098.65717	2563.073	-2067.8586	3532.274
2026	723.6068	-1250.72629	2697.940	-2295.8751	3743.089
2027	720.1359	1394.13130	2834.403	-2513.3568	3953.629

Fig:18 Production forecast

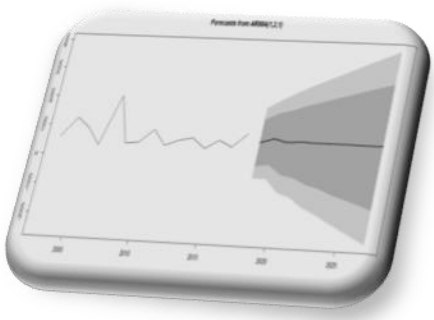


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Table -4 AREA, YIELD, AND PRODUCTTION POINT FORECAST(COASTAL ANDHRA REGION)

Area Point Forecast of Groundnut (COASTAL REGION)

Year	Area Point forecast	Lo 80	Hi 80	Lo95	Hi 95
2018	30.313146	13.4849095	47.14138	47.14138	56.04971
2019	23.270686	0.4993657	46.04201	-11.555043	58.09642
2020	16.282895	-11.9052322	44.47102	44.47102	59.39292
2021	9.286700	-23.8423228	42.41572	-41.379768	59.95317
2022	2.291796	-35.5194736	40.10307	-55.535551	60.11914
2023	-4.703306	-47.0197310	37.61312	-69.420693	60.01408
2024	-11.698378	-58.3947964	34.99804	-83.114387	59.71763
2025	-18.693454	-69.6768774	32.28997	-96.665871	59.27896
2026	-25.688529	-80.8876528	29.51059	-110.108304	58.73124
2027	-32.683605	-92.0423157	26.67511	-123.464919	58.09771

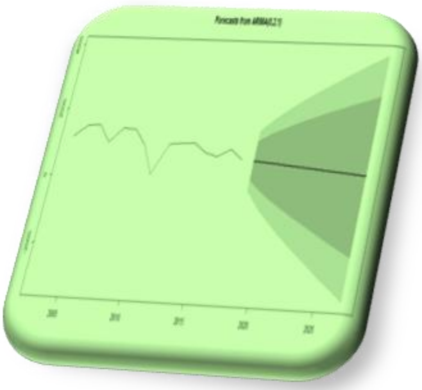

Fig: 19 Area forecast

Yield Point Forecast(COASTAL REGION)

Year	Yield point forecast	Lo 80	Hi 80	Lo95	Hi 95
2018	25404.50	22497.42	28311.58	20958.51	29850.49
2019	26290.00	22043.95	30536.06	19796.22	32783.79
2020	27175.51	21815.12	32535.89	18977.50	35373.51
2021	28061.01	21691.92	34430.10	18320.33	37801.69
2022	28946.51	21630.53	36262.50	17757.68	40135.35
2023	29832.01	21609.56	38054.47	17256.85	42407.18
2024	30717.52	21616.92	39818.11	16799.36	44635.67
2025	31603.02	21645.13	41560.91	16373.74	46832.30
2026	32488.52	21689.21	43287.84	15972.39	49004.65
2027	33374.02	21745.71	45002.33	15590.06	51157.99

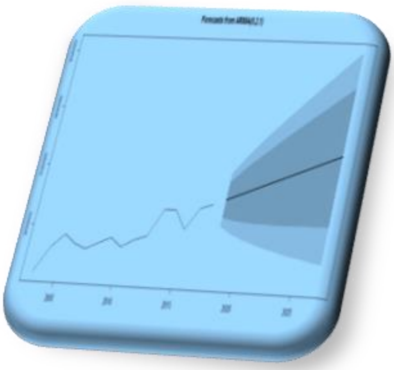

Fig:20 Yield forecast

Production Point Forecast(COASTAL REGION)

Year	Production Point forecas	Lo 80	Hi 80	Lo95	Hi 95
2018	129.4848	105.739621	153.2300	93.16968	165.7999
2019	122.6794	90.200070	155.1586	73.00657	172.3521
2020	108.9265	71.588542	146.2645	51.82301	166.0300
2021	120.9781	70.405265	171.5510	43.63361	198.3226
2022	122.8605	58.419666	187.3014	24.30673	221.4143
2023	112.2065	37.588853	186.8241	-1.91134	226.3243
2024	116.2073	27.936700	204.4780	-18.79096	251.2057
2025	120.5945	16.284411	224.9046	-38.93402	280.1230
2026	114.2439	-4.218647	232.7065	-66.92895	295.4168
2027	113.9214	-19.846723	247.6895	-90.65927	318.5020

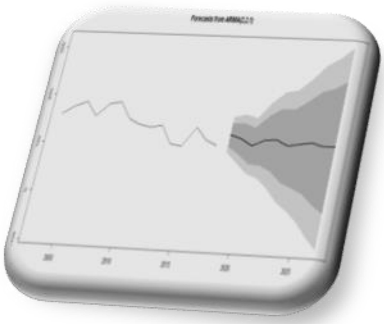

Fig:21 Production forecast

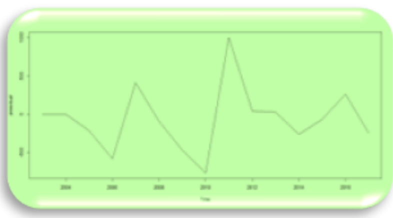

Fig:22. Area-Residuals(CEDED)

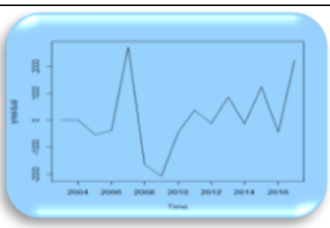

Fig:23:Yield-Residua(Ceded)

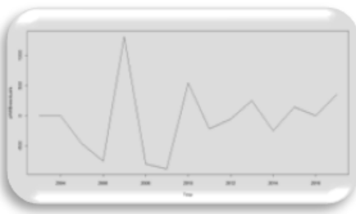

Fig:24 Prod.-Residuals(Ceded)

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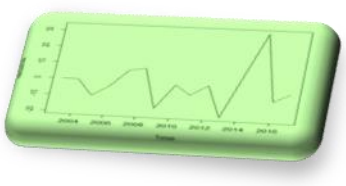
Table-5 Residuals & Predictive values of Area, Yield and Productions(CEDED REGION)

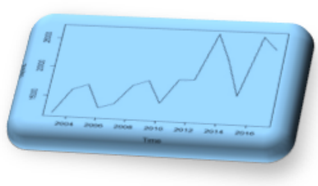
year	A residuals	Y residuals	P residuals	A predective	Y predictive	P predective
2003	0.5205565	1.191376	0.2696697	1164.5206	266.1914	603.2697
2004	-0.7857512	-1.805380	0.6757360	1510.2142	3453.1946	1267.6757
2005	*-214.9619841*	-533.095212	-463.3631946	1339.0380	2266.9048	460.6368
2006	-578.0808788	-397.622113	-754.3694676	462.9191	2124.3779	-388.3695
2007	410.4950817	2709.383368	1316.2430014	1884.4951	8987.3834	3392.2430
2008	-93.4683524	-1638.368125	-797.0453050	1353.5316	339.6319	-326.0453
2009	-467.9382883	-2070.179756	-883.6285771	523.0617	517.8202	-390.6286
2010	-764.8823535	-450.995919	540.5922361	-628.8824	3015.0041	1502.5922
2011	999.8238396	370.213894	-217.0168277	2057.8238	3051.2139	226.9832
2012	41.7188844	-116.687055	-57.7366664	1130.7189	2783.3129	577.2633
2013	28.7763566	859.505100	252.7839521	1139.7764	4792.5051	991.7840
2014	-260.9630661	-144.666116	-250.2469229	571.0369	2629.3339	140.7531
2015	-66.8461418	1241.299335	145.7239208	665.1539	6026.2993	839.7239
2016	261.3288712	-442.772159	2.3333701	1229.3289	2669.2278	487.3334
2017	-246.6139287	2196.844463	358.7155252	450.3861	8439.8445	1300.7155

Table-6 Residuals & Predictive values of Area, Yield and Productions(COASTAL ANDHRA REGION)

year	A residuals	Y residuals	P residuals	A predective	Y predictive	P redective
2003	0.05992661	5.421122	0.07110694	134.05993	12127.42	159.07111
2004	-0.17530698	-7.035089	-0.17754246	135.82469	16241.96	174.82246
2005	-9.75765955	1334.323530	-2.62360133	113.24234	17154.68	183.37640
2006	-3.70558785	-3766.917577	-24.31993545	110.29441	13292.08	132.68006
2007	6.55777815	-2150.927389	19.73043580	121.55778	14070.07	202.73044
2008	8.12492792	39.571429	-8.45449021	126.12493	17329.57	179.54551
2009	-15.87964846	-6.943517	-15.82348111	80.12035	18309.06	138.17652
2010	-1.17360226	-2309.309307	-22.50726628	89.82640	14544.69	120.49273
2011	-6.96986748	531.311061	-19.24844333	70.03013	18629.31	118.75156
2012	-0.83489672	-48.087117	20.78926920	69.16510	18745.91	163.78927
2013	-19.61687161	3508.860583	-21.85512723	22.38313	26742.86	84.14487
2014	5.89437125	-1017.538421	5.02948856	47.89437	22260.46	107.02949
2015	32.44007125	-3902.650475	35.66558397	98.44007	16313.35	177.66558
2016	-8.91152621	2760.767403	1.60879507	37.08847	26524.77	118.60880
2017	-4.15845853	-135.428640	8.16232185	32.84154	24383.57	114.16232

Fig:25. Area-Residuals **Fig:26:Yield-Residuals** **Fig:27 Prod.- Residuals**





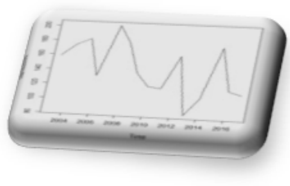


Table-7 Area, yield , and Production predictive (CEDED REGION & Coastal Region)

	CEDED REGION			Coastal Region		
year	Area predictive	Yield predictive	Prod. predective	A REA Predictive	YIELD predictive	P RODUCTION predictive
2018	663.64312	4338.339	670.0918	30.313146	25404.50	18.52847
2019	630.28624	5078.286	818.4277	23.270686	26290.00	25.34372
2020	596.92936	5563.951	724.4765	16.282895	27175.51	29.13498
2021	563.57247	5098.539	770.2133	9.286700	28061.01	39.46221
2022	530.21559	5657.126	735.4144	2.291796	28946.51	50.28347
2023	496.85871	5666.277	747.0475	-4.703306	29832.01	58.22446
2024	463.50183	5738.279	731.9108	-11.698378	30717.52	68.87795

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2025	430.14495	5998.293	732.2079	-18.693454	31603.02	81.39360
2026	396.78807	6050.198	723.6068	-25.68529	32488.52	92.43685
2027	363.43118	6216.148	720.1359	-32.683605	33374.02	104.37980
2028	330.07430	6367.048	713.7073	-39.678681	34259.53	118.01384
2029	296.71742	6480.838	708.9839	-46.673756	35145.03	131.27342
2030	263.36054	6636.899	703.2773	-53.668832	36030.53	144.74957
2031	230.00366	6769.308	698.1376	-60.663908	36916.03	159.43533
2032	196.64678	6905.240	692.6710	-67.658983	37801.53	174.34269
2033	163.28990	7048.485	687.3929	-74.654059	38687.04	189.32485
2034	129.93301	7183.148	682.0062	-81.649135	39572.54	205.09936
2035	96.57613	7322.712	676.6820	-88.644210	40458.04	221.33180
2036	63.21925	7461.466	671.3218	-95.639286	41343.54	237.69702
2037	29.86237	7598.782	665.9824	-102.634362	42229.05	254.58425

Table-8 Time series data values of Area, Yield and Production(CEDED REGION & COASTAL REGION)

CEDED REGION				COASTAL REGION		
Year	TIMESERIES DATA-area	TIMESERIES DATA-yield	TIMESERIES DATA-prod.	TIMESERIES DATA-AREA	TIMESERIES DATA-YIELD	TIMESERIES DATA-PROD.
2003	1164	2665.1914	603.2697	134.05993	12127.42	159.07111
2004	1511	3453.1946	1267.6757	135.82469	16241.96	174.82246
2005	1554	2266.9048	460.6368	113.24234	17154.68	183.37640
2006	1041	2124.3779	-388.3695	110.29441	13292.08	132.68006
2007	1474	8987.3834	3392.2430	121.55778	14070.07	202.73044
2008	1447	339.6319	-326.0453	126.12493	17329.57	179.54551
2009	991	517.8202	-390.6286	80.12035	18309.06	138.17652
2010	136	3015.0041	1502.5922	89.82640	14544.69	120.49273
2011	1058	3051.2139	226.9832	70.03013	18629.31	118.75156
2012	1089	27832.3129	577.2633	69.16510	18745.91	163.78927
2013	1111	4792.5051	991.7840	22.38313	26742.86	84.14487
2014	832	2629.3339	140.7531	47.89437	22260.46	107.02949
2015	732	6026.2993	839.7239	98.44007	16313.35	177.66558
2016	968	2669.2278	487.3334	37.08047	26524.77	118.60880
2017	697	8439.8445	1300.7155	32.84154	24383.57	114.16232

Fig: 28 **Time series data values of Area, Yield and Production(CEDED REGION)**

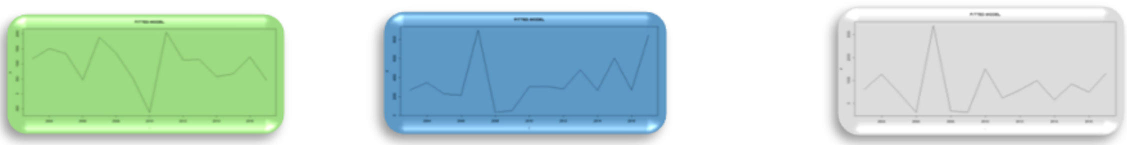

Fig: 29 **Time series data values of Area, Yield and Production(COASTAL REGION)**

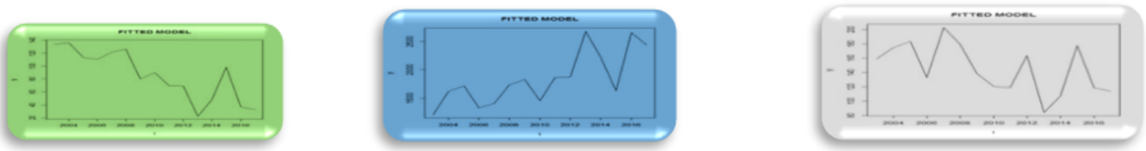

Table-9 Area, yield and Production Training Set error measure

CEDED REGION	ARIMA	Training set error measures						
		ME	RMSE	MAE	MPE	MAPE	MASE	ACF
AREA	(1 , 2, 1)	-63.45848	413.5649	295.8136	-40.37166	61.14672	0.913206	-0.2363987
YIELD	(0, 2, 1)	105.483	1222.83	878.3086	-60277613	24.9433	0.5778618	-0.13744871
PRODUCTION	(2, 1, 2)	-53.73797	550.8458	402.7163	-34.2153	62.67673	0.7516369	-0.388102
COASTAL ANDHRA REGION								
AREA	(1 , 2 ,1)	-1.20709	11.80239	8.284033	-2.725881	12.83502	0.7387036	-0.1005916
YIELD	(0,2,1)	-522.2153	2040.165	1435.006	-3.393128	7.383666	0.7732607	-0.05819921
PRODUCTION	(1, 2 ,1)	-1.596859	17.24914	13.73779	-1.172856 9.	9.771143	0.7425834	-0.09666837

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V. CONCLUSION

A. Area of Groundnut Crop Conclusion

Table-10 Identification of ARIMA(p,d,q) MODEL for AREA in Ceded & Coastal Andhra Regions

Identification of ARIMA(p,d,q) MODEL for AREA (Ceded Region)							
Model	**Area ARIMA**	**Coefficients**	**SE**	**Intercept**	**σ^2**	**Log likelyhood**	**AIC**
(1,0,1)	**AR1**	**0.0498**	**0.5624**	**1046.008**	**115069**	**-108.74**	**225.49**
	MA1	**0.2924**	**0.5138**	**117.233**			
(1,1,1)	**AR1**	**0.1970**	**0.3672**		**134509**	**-102.82**	**211.65**
	MA1	**-0.7633**	**0.2536**				
	AR2	**-0.3039**	**0.2835**				
	MA1	**-0.5565**	**0.3623**				
(0,1,1)	**MA1**	**-0.6696**	**0.2105**		**137404**	**-102.98**	**209.95**
(1,2,1)	**AR1**	**-0.2117**	**0.2744**		**183257**	**-98.74**	**203.48**
	MA1	**-1.000**	**0.2106**				
(1,1,0)	**AR1**	**-0.2581**	**0.2570**		**171256**	**-104.26**	**212.51**
(1,1,2)	**AR1**	**-0.1588**	**0.7451**		**131574**	**-102.68**	**213.35**
	MA1	**-0.3572**	**0.6960**				
	MA2	**-0.2946**	**0.4351**				
(1,2,0)	**AR1**	**-0.4470**	**0.2389**		**378348**	**-102.04**	**208.08**
(0,2,1)	**MA1**	**-1.000**	**0.2025**		**197349**	**-99.02**	**202.04**
Identification of ARIMA(p,d,q) MODEL for AREA in (Coastal Andhra Region)							
model	**Area ARIMA**	**Coefficients**	**SE**	**Intercept**	**σ^2**	**Log likelyhood**	**AIC**
(1,0,1)	**AR1**	**0.9190**	**0.1088**	**85.7207**	**198.3**	**-62.03**	**132.07**
	MA1	**0.1533**	**0.3450**	**32.5630**			
(1,1,1)	**AR1**	**-0.8244**	**0.2173**		**184.7**	**-56.82**	**119.65**
	MA1	**0.9999**	**0.4058**				
(2,2,1)	**AR1**	**-0.2573**	**0.2572**		**131.5**	**-52.07**	**112.14**
	AR2	**-0.3591**	**0.2522**				
	MA1	**-1.0000**	**0.2971**				
(1,2,2)	**AR1**	**0.4313**	**0.3430**		**114.8**	**-52.14**	**112.29**
	MA1	**-1.9696**	**0.4247**				
	MA2	**0.9999**	**0.4251**				
(1,1,0)	**AR1**	**0.0648**	**0.2612**		**203.3**	**-57.07**	**118.14**
(0,0,1)	**MA1**	**0.9157**	**0.2666**	**86.4312**	**431**	**-67.66**	**141.32**
				10.0006			
(1,2,0)	**AR1**	**-0.4331**	**0.2426**		**321.5**	**-56.07**	**116.15**
(1,0,0)	**AR1**	**0.9418**	**0.702**	**86.0175**	**200.7**	**-62.14**	**130.27**
				35.3574			

In the present study, the ARIMA (1,2,1) in Ceded Region & ARIMA (2,2,1) in Coastal Region were the best fitted model through the minimum value of AIC, then used for prediction up to 10 years of the area of groundnut in ceded districts using 15 years time series data i.e. from 2003-2004 to2017-2018. ARIMA(1,2,1) in Ceded Region & ARIMA (2,2,1) in Coastal Region were used because the reason of its capability to make prediction using time series data with any kind of patterns and with auto correlated successive values of the time series. The study was also validated and statistically tested that the successive residuals in the fitted ARIMA (1, 2,1) in Ceded Region & ARIMA (2,2,1) in Coastal Region were not correlated, and the residuals appear to be normally distributed with the mean zero and constant variance. Hence, it can be a satisfactory predictive model for the groundnut area in ceded districts in Andhra Pradesh for the period of 2018 to 2027. The ARIMA (1,2,1) in Ceded Region & ARIMA (2,2,1) in Coastal Region models projected an increment in the area for the duration of 2018 to 2027. The prediction of 2027 is resulted approximately **363.4312**'000 ha & **-32.683605**"000 ha. Like any other predictive models for forecasting , ARIMA model has also limitations on accuracy of the predictions yet it is widely used for forecasting the future values for time series.

B. Yield of Groundnut Crop Conclusion

Table 11 Identification of ARIMA(p,d,q) MODEL for Yield in Ceded & Coastal Andhra Regions

Identification of ARIMA(p,d,q) MODEL for YIELD (CEDED REGION)							
Model	**YIELD ARIMA**	**Coefficie nts**	**SE**	**Intercept**	**σ^2**	**loglikely-hood**	**AIC**

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(1,2,2)	**AR1**	**-0.4498**	**0.3036**		**1951664**	**-114.66**	**237.32**
	MA1	**-1.4436**	**0.3670**				
	MA2	**0.5442**	**0.3058**				
(2,2,1)	**AR**	**-0.9559**	**0.2468**		**1725361**	**-114.44**	**236.89**
	AR2	**-0.4515**	**0.2410**				
	MA1	**-1.0000**	**.7099**				
(1,1,2)	**AR1**	**-0.3016**	**0.5638**		**1648515**	**-120.7**	**249.41**
	MA1	**-0.8152**	**0.4808**				
	MA2	**0.2104**	**0.6083**				
(1,0,0)	**AR1**	**-0.4288**	**0.2773**	**3437.8939**	**1374004**	**-127.38**	**260.77**
				217.0428			
(0,0,1)	**MA1**	**-0.4099**	**0.3307**	**3423.1423**	**1403675**	**-127.54**	**261.07**
				195.9421			
(1,0,1)	**AR1**	**-0.4054**	**0.5620**	**3437.076**	**1373603**	**-127.38**	**262.77**
	MA1	**-0.0303**	**0.6045**	**215.595**			
Identification of ARIMA(p,d,q) MODEL for YIELD(COASTAL ANDHRA REGION)							
Model	**YIELD ARIMA**	**Coefficients**	**SE**	**Intercept**	**σ^2**	**loglikely-hood**	**AIC**
(1,1,1)	**AR1**	**0.3432**	**0.7610**		**5185326**	**-128.1**	**262.21**
	MA1	**-0.4558**	**0.6856**				
(2,1,1)	**AR1**	**-0.3786**	**1.0185**		**4269286**	**-127.02**	**262.03**
	AR2	**-0.4795**	**0.3230**				
	MA1	**0.3476**	**1.2693**				
(1,0,1)	**AR1**	**0.4863**	**0.4462**	**18661.461**	**4814922**	**-137.4**	**282.8**
	MA1	**0.667**	**00.478**	**1712.654**			
(0,2,1)	**MA1**	**-1.0000**	**0.2202**		**4802619**	**-119.77**	**243.53**
(1,2,1)	**AR1**	**-0.1537**	**0.2740**		**160.7**	**-52.93**	**111.86**
	MA1	**-1.0000**	**0.2183**				

In the present study, ARIMA (1, 2 ,1) in ceded and ARIMA (2,2,1)coastal Andhra regions) were the best fitted models through the minimum value of AIC, then used for prediction up to 10 years of the yield of groundnut in ceded districts using 15 years time series data i.e. from 2003-2004 to 2017-2018. ARIMA (1, 2 ,1) , ARIMA (2,2,1)coastal Andhra regions used because the reason of its capability to make prediction using time series data with any kind of patterns and with auto correlated successive values of the time series. The study was also validated and statistically tested that the successive residuals in the fitted ARIMA (1,2 ,1)ceded region, ARIMA (2,2,1)coastal Andhra regions were not correlated, and the residuals appear to be normally distributed with the mean zero and constant variance. Hence, it can be a satisfactory predictive model for the groundnut yield in ceded districts in Andhra Pradesh for the period of 2018 to 2027. The ARIMA (1,2,1) ceded region, ARIMA (2,2,1)coastal Andhra regions model projected an increment in the yield for the duration of 2018 to 2027. The prediction of 2027 is resulted approximately **6216.148** 'kg/ ha .(Ceded Region) & **33374.02** 'kg/ha(Coastal Andhra Region). Like any other predictive models for forecasting, ARIMA model has also limitations on accuracy of the predictions yet it is widely used for forecasting the future values for time series.

C. Production of Groundnut Crop Conclusion

TABLE-12 Identification of ARIMA(p,d,q) MODEL for Production in Ceded & Coastal Andhra Regions

Identification of ARIMA(p,d,q) MODEL for PRODUCTION(CEDED REGION)							
Model	**PROD. ARIMA**	**Coefficients**	**SE**	**Intercept**	**σ^2**	**Log likelihood**	**AIC**
(1,0,1)	**AR1**	**-0.2205**	**0.4445**	**765.2733**	**159820**	**-111.21**	**230.42**
	MA1	**-0.1346**	**0.4025**	**74.9200**			
(2,1,1)	**AR1**	**-0.9458**	**0.2739**		**139690**	**-103.77**	**215.54**
	AR2	**-0.6215**	**0.2299**				
	MA1	**-0.2511**	**0.4060**				
(1,0,0)	**AR1**	**-0.3329**	**0.2349**	**765.9133**	**161114**	**-111.27**	**228.53**
				79.0824			
	MA1	**-0.7552**	**0.2130**				
Identification of ARIMA(p,d,q) MODEL for PRODUCTION(COASTAL ANDHRA REGION)							
Model	**PROD. ARIMA**	**Coefficients**	**SE**	**Intercept**	**σ^2**	**Log likelihood**	**AIC**
(1,2,0)	**AR1**	**-0.4091**	**0.2393**		**1027**	**-63.61**	**131.22**
(1,1,2)	**AR1**	**-0.3850**	**0.3058**		**306.1**	**-60.87**	**129.73**
	MA1	**0.4757**	**0.2873**				
	MA2	**-0.5243**	**0.2372**				

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(1,2,1)	**AR1**	**-0.1537**	**0.2740**		**160.7**	**-52.93**	**111.86**
	MA1	**-1.0000**	**0.2183**				
(1,0,1)	**AR1**	**0.1425**	**0.2586**	**146.7956**	**328.6**	**-66.27**	**140.54**
	MA1	**1.0000**	**02214**	**10.4633**			

In the present study, the ARIMA (2,1,1)in Ceded Region & ARIMA(1,2,1)in Coastal Andhra Region were the best fitted model through the minimum value of AIC, then used for prediction up to 10 years of the production of groundnut in ceded districts using 15 years time series data i.e. from 2003-2004 to 2017-2018. ARIMA (2,1,1) in Ceded Region & ARIMA(1,2,1)in Coastal Andhra Region were used because the reason of its capability to make prediction using time series data with any kind of patterns and with auto correlated successive values of the time series. The study was also validated and statistically tested that the successive residuals in the fitted ARIMA (2,1,1) in Ceded Region & ARIMA (1,2,1)in Coastal Andhra Region were not correlated, and the residuals appear to be normally distributed with the mean zero and constant variance. Hence, it can be a satisfactory predictive model for the groundnut yield in ceded districts in Andhra Pradesh for the period of 2018 to 2027. The ARIMA (2, 1, 1) in Ceded Region & ARIMA(1,2,1)in Coastal Andhra Region models projected an increment in the production for the duration of 2018 to 2027. The prediction of 2027 is resulted approximately **720.1359**'000 tonnes(Ceded Region) & **163.78927**'000 tonnes(Coastal Andhra Region). Like any other predictive models for forecasting, ARIMA model has also limitations on accuracy of the predictions yet it is widely used for forecasting the future values for time series. It is noticed that in Groundnut production Ceded Region is better than Coastal Andhra Region. The empirical **Forecasting area, yield and production of groundnut crop: a comparative study of coastal andhra and ceded regions using- R findings** of study could help to forecast any such commodities. The researchers and policy makers will thus get access for making further extensive research work. We firmly believe that this research has shed some important light on the subject area encompassing time series forecasts of selected agricultural crops in Seemandhra. These empirical findings can be an important source of information to many researchers and policy formulators as far as agricultural crops in Seemandhra are concerned.

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