Forecasting Area, Yield, And Production In Anantapur District : Case of Groundnut Crop Using – R

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ABSTRACT

Groundnut is an important cash crop in India. Groundnut is also called wonder nut as well as poor men's cashew nut. Anantapur is popular as groundnutcity. Groundnut is king of oilseeds. This study focuses on forecasting the cultivated area yield and production of groundnut in Anantapur district using Auto Regressive Integrated Moving Average(ARIMA) using R. Time series data covering the period of 2003-2018 was used of Anantapur district of was used for the study. The study is to identify the best ARIMA model, which is for fitting and forecasting of Groundnut Area, Yield, Production in Anaantapur district respectively. Conclusions are drawn and found the forecasting for the future. The R-Software is used to analyse and graphical representation of the results.

Keywords: *ARIMA, Forecasting, Auto Correlation Function, Akaike Information Criterion, R-software.*

I. INTRODUCTION

The forecasts are estimates of the demand over future time intervals and are generated using the flow of demands from the past. In other words, forecasting is the predication of a variable based on known past values of that variable or other related variables. The forecasting of the ground nut area will be helpful to policy makers in formulating appropriate policy measures in order to ensure increased area under the crop and enhanced production. India accounts for about 18.60 percent of world area and 16.77 per cent of world production of groundnut. Crop yield depends on nutrition level of soils, fertilizer availability and cost, pest control, agro-meteorological input parameters like temperature, rainfall and other factors. Crop production includes all the feed sources that are to maintain and the resource inputs used to produce the crops.

All India groundnut acreage was 38,90,000 hectares. Five states, Gujarat(14,67,600 ha; 37.7%), Andhrapradesh (6,60,000 ha; 17%), Rajasthan(5,49,052 ha; 14.1%), Karnataka(3,82,940 ha; 9.8%), Maharashtra(1,95,594 ha; 5%) jointly accounted for 83.7%of the National acreage. India ranks first in groundnut acreage with about 80.85 lakh metric tonnes (in shell groundnuts), second in production. Gujarat is the largest producer of Groundnut. Groundnut requires an average daily temperature to grow is 30°C and growth ceases at 15°C. For rapid emergence, soil temperature above 21°C is needed. The optimum temperature for most rapid germination and seedling development is about 30° C.

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 crop can be grown successfully in places receiving a minimum rainfall of 500 mm and a maximum rainfall of 1250 mm. The rainfall should be distributed well during the flowering and pegging of the crop. 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].

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(1976). 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. Ashwini Darekar et al (2017) for forecasting oilseeds prices in India: Case of groundnut [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 Baangladesh [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 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 Iqbal Ch et al.(2016) for forecasting of wheat production: A comparative study of Pakistan and India [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], Bhola Nath et al.(2018) DS , Forecasting Wheat production in India: An ARIMA modelling approach [13] , Pant, D.C. and Pradeep Pal, et al.(2004*),* Comparative Economics of Agro-processing units for Groundnut in Southern Rajasthan [14], Ap Patel, G.N., and N.L. Agarwal et al. (1993*),* Price Behaviour of Groundnut in Gujarat [15], 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.

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R- software: R, which is free, open-source, and extremely powerful software. R language is a programming language developed by Ross Ihaka and Robert Gentleman in 1993. It has many built-in functions and libraries, and is extensible, allowing users to define their own functions and procedures using R, C or Fortran. 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.

II. MATERIALS AND METHODS

(i)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 data of groundnut crop producing in Anantapuramu districts of Andhra Pradesh. Anantapur district is bounded by Kurnool District in the north; Cuddapah District in the north-east; Chittor District in the south-east; and Karnataka State on the West . The district has a total geographical area of 19.13 lakh hectare. As per 2001 census, the district has 10 towns and 964 revenue villages and a total population of 3.64 million. Almost 75 percent of the population in the district lives in rural areas. Agriculture remains the predominant activity in the villages, with 80 percent of total workers engaged in agriculture, either as cultivators or agricultural labourers. Level of rainfall as well as effective rainfall is low with a high probability of dry-spell occurrence in the growing period. During southwest monsoon, the quantum of rainfall is lower than potential evapotranspiration, thus having serious implications for crop growth.

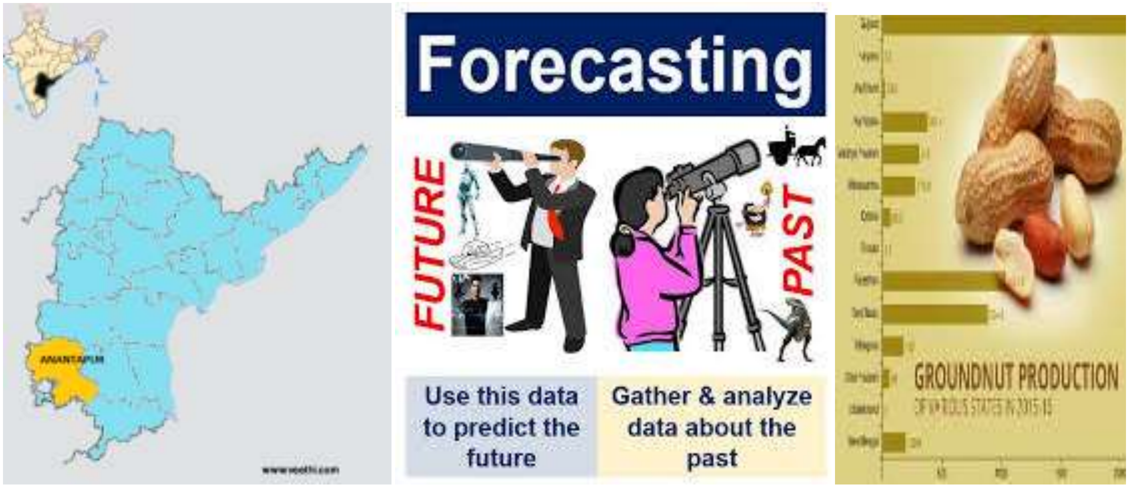


Fig: 1 Area, Yield, and Production of Groundnut crop in Anantapur district of Andhra Pradesh.

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

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.

A. 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 [16] 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.

***B. 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.

***C. 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.

D. 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.

S.NO	YEAR	Area (in 000'ha.)	Yield (in Kg/ha.)	Prod. (in 000'tones)
1	2003-2004	686		208
2	2004-2005	872	2297	706
3	2005-2006	899	1765	392
4	2006-2007	662	1116	62
5	2007-2008	897	2566	1130
6	2008-2009	871	1563	100
7	2009-2010	530	1661	142
8	2010-2011	834	2253	481
9	2011-2012	754	1883	208
10	2012-2013	730	2057	330
11	2013-2014	728	1925	313
12	2014-2015	566	1920	173
13	2015-2016	468	2096	352
14	2016-2017	624	1774	165
15	2017-2018	423	3095	455
	TOTAL	10544	29567	5217

Fig : 2 AREA, YIELD AND PRODUCTION OF GROUNDNUT CROP IN ANANTAPUR DISTRICT

Table-2

Area, Yield and Production ACF and PACF(ANANTAPUR DISTRICT)

Lag	ACF(area)	PACF(area)	ACF(YIELD)	PACF(YIELD)	ACF(PROD.)	PACF(PROD)
0	**1.000**	**0**	**1.000**	**0**	**1.000**	**0**
1	**0.213**	**0.123**	-0.331	-0.331	-0.444	-0.444
2	**0.210**	**0.173**	-0.026	-0.152	-0.123	-0.399
3	**0.375**	**0.325**	0.326	0.305	0.488	0.347
4	**-0.125**	**-0.318**	-0.229	-0.025	-0.346	0.035
5	**-0.051**	**-0.120**	0.100	0.045	0.058	0.056
6	**0.092**	**0.095**	-0.015	-0.098	0.048	-0.238
7	**-0.228**	**-0.091**	0.060	0.139	-0.137	-0.115
8	**0.011**	**0.082**	-0.026	-0.022	0.083	-0.050
9	**-0.220**	**-0.375**	-0.236	-0.274	-0.178	-0.184
10	**-0.350**	**-0.186**	0.266	0.068	0.074	-0.063
11	**-0.120**	**-0.011**	0.266	-0.180	-0.012	-0.105
12	**-0.187**	**0.157**			-0.058	0.086
13	**-0.134**	**0.083**			0.060	-0.041
14	**0.014**	**-0.209**			-0.014	0.016

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

Fig:3 Area- ACF(**ANANTAPUR DISTRICT**)

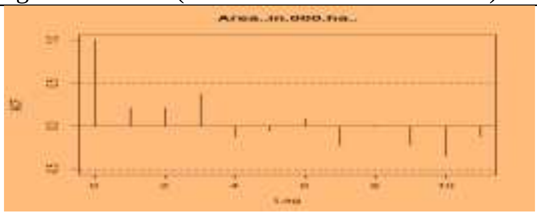


Fig: 4 AREA- PACF(**ANANTAPUR DISTRICT**)

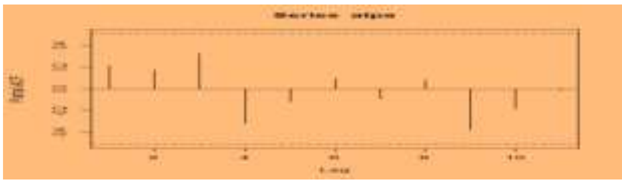


Fig:5 Yield- ACF (**ANANTAPUR DISTRICT**)

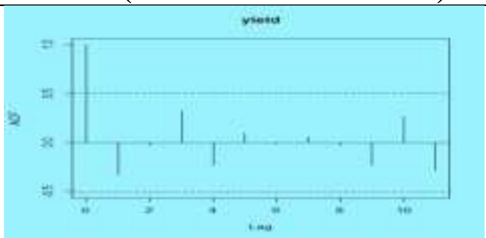


Fig: 6 YIELD - PACF(**ANANTAPUR DISTRICT**)

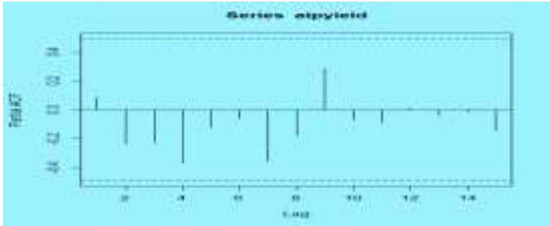


Fig :7 Production -ACF (**ANANTAPUR DISTRICT**)

Fig:8 PRODUCTION- PACF(**ANANTAPUR DISTRICT**)

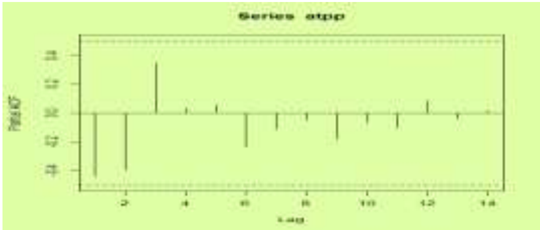


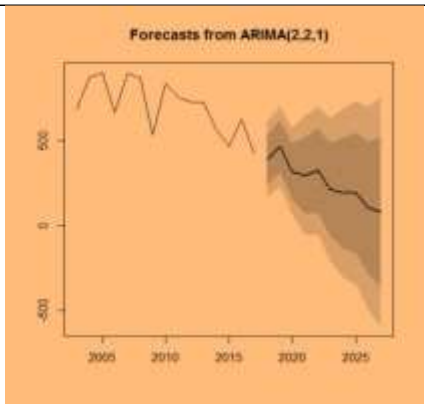
Table-3

AREA, YIELD, AND PRODUCTTION POINT FORECAST

Area Point Forecast of (ANANTAPUR DISTRICT)

Year	Area Point forecast	Lo 80	Hi 80	Lo95	Hi 95
2018	2410.573	2104.499	2716.646	1942.474	2878.672
2019	2656.705	2241.135	3072.275	2021.146	3292.265
2020	2508.976	2050.016	2967.937	1807.057	3210.895
2021	2652.940	2082.607	3223.272	1780.692	3525.188
2022	2676.762	2050.143	2967.937	1807.057	3210.895
2023	2652.940	2082.607	3223.272	1780.692	3525.188
2024	2676.762	2050.143	3303.381	1718.431	3635.094
2025	2685.906	1988.104	3383.709	1618.710	3753.103
2026	2770.456	1999.724	3541.189	1591.723	3949.190
2027	2780.765	1949.315	3612.215	1509.172	4052.358

Fig: 9 Area forecast



Yield Point Forecast (ANANTAPUR DISTRICT)

Fig:10 Yield forecast

Year	Yield point forecast	Lo 80	Hi 80	Lo95	Hi 95
2018	1971.315	1350.115	2592.514	1021.272	2921.357
2019	1971.315	1350.115	2592.514	1021.272	2921.357
2020	1971.315	1350.115	2592.514	1021.272	2921.357
2021	1971.315	1350.115	2592.514	1021.272	2921.357
2022	1971.315	1350.115	2592.514	1021.272	2921.357
2023	1971.315	1350.115	2592.514	1021.272	2921.357
2024	1971.315	1350.115	2592.514	1021.272	2921.357
2025	1971.315	1350.115	2592.514	1021.272	2921.357
2026	1971.315	1350.115	2592.514	1021.272	2921.357
2027	1971.315	1350.115	2592.514	1021.272	2921.357

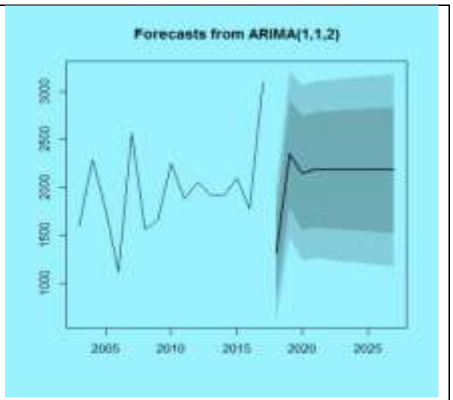


Fig:11 Production forecast

Production Point Forecast (ANANTAPUR DISTRICT)

Year	Production Point forecas	Lo 80	Hi 80	Lo95	Hi 95
2018	102.41338	-168.75455	373.5813	-312.3022	517.1289
2019	198.73887	-98.51373	495.9915	-255.8697	653.3475
2020	286.01453	-18.85858	590.8876	-180.2487	752.2777
2021	113.05320	-224.02235	450.1287	-402.4594	628.5658
2022	173.26359	-163.43661	509.9638	-341.6749	688.2021
2023	184.84892	-161.96286	531.6607	-345.5539	715.2518
2024	99.70698	-259.42258	458.8365	-449.5343	648.9482
2025	128.26930	-229.79311	486.3317	-419.3399	675.8785
2026	115.09489	-252.62665	482.8164	-447.2867	677.4764
2027	70.52825	304.87000	445.9265	-503.5938	644.6503

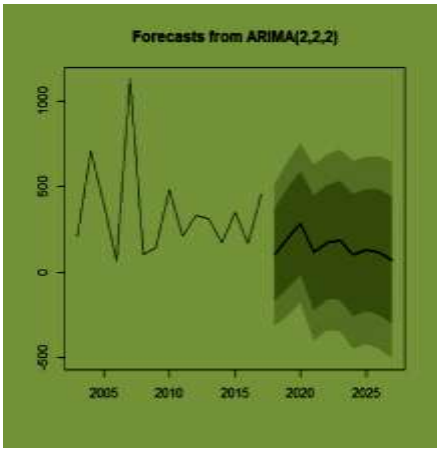


Table-4
Actual, Residuals & Predictive values of Area, Yield and Productions(ANANATAPUR DISTRICT)

Year	AREA	A residuals	A predective	YIELD	Y residuals	Y predictive	PROD	P-predictive	P-residuals
2003	686	0.3067883	686.3068	1596	1.595995	1597.5960	208	208.09302	0.09302028
2004	872	-0.5044500	871.4955	2297	274.341913	2571.3419	706	706.83448	0.83448002
2005	899	-58.3788567	840.6211	1765	-6.416153	1758.5838	392	191.24292	-200.75707677
2006	662	-161.9054569	500.0945	1116	-620.951275	495.0487	62	-130.40721	-192.40721337
2007	897	45.2936366	942.2936	2566	200.869067	2766.8691	1130	1535.94783	405.94783184
2008	871	4.8019419	875.8019	1563	59.209099	1622.2091	100	-67.43957	-167.43957208
2009	530	-191.8426825	338.1573	1661	-135.310744	1525.6893	142	-119.49523	-261.49522660
2010	834	20.2437904	854.2438	2253	291.765423	2544.7654	481	190.04554	-290.95445743
2011	754	-9.9784632	744.0215	1883	315.870573	2198.8706	208	164.94878	-43.05122170
2012	730	174.0276895	904.0277	2057	342.085624	2399.0856	330	442.28829	112.28828912
2013	728	-80.0315495	647.9685	1925	188.033079	2113.0331	313	360.23219	47.23219362
2014	566	-158.5424877	407.4575	1920	-13.624974	1906.3750	173	174.76219	1.76219426
2015	468	-187.2980780	280.7019	2096	-18.447359	2077.5526	352	445.61794	93.61794087
2016	624	50.8832957	674.8833	1774	-286.112170	1487.8878	165	160.83593	-4.16407347
2017	423	**-36.8985221**	386.1015	3095	736.406127	3831.4061	455	717.41375	262.41374660

Table-5

Area, yield , and Production predictive (ANANTAPUR DISTRICT)

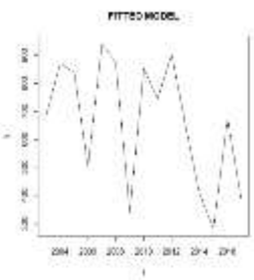
year	Area predictive	Yield predictive	Prod. predective
2018	389.471303	1320.767	102.413378
2019	467.621464	2346.791	198.738866
2020	318.408416	2150.503	286.014532
2021	295.191338	2188.055	113.053197
2022	325.313049	2180.871	173.263591
2023	212.599315	2182.245	184.848918
2024	191.558975	2181.982	99.706978
2025	192.512672	2182.033	128.269300
2026	105.006072	2182.023	115.094886
2027	82.490866	2182.025	70.528254
2028	66.039731	2182.025	78.368299
2029	-4.361069	2182.025	59.092873
2030	-29.655128	2182.025	32.244447
2031	-56.282038	2182.025	28.221523
2032	-115.255416	2182.025	8.744889
2033	-143.486140	2182.025	-10.841090
2034	-175.917336	2182.025	-21.100095
2035	-227.366506	2182.025	-39.456980
2036	-258.197558	2182.025	-56.297869
2037	-293.837275	2182.025	-69.628326

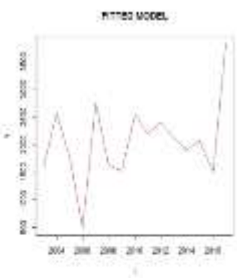
Table-6

Time series data values of Area, Yield and Production (ANANTAPUR DISTRICT)

Year	TIME SERIES A-DATA	TIME SERIES Y-DATA	TIME SERIES P-DATA
2003	686.3068	1597.5960	208.09302
2004	871.4955	2571.3419	706.83448
2005	840.6211	1758.5838	191.24292
2006	500.0945	495.0487	-130.40721
2007	942.2936	2766.8691	1535.94783
2008	875.8019	1622.2091	-67.43957
2009	338.1573	1525.6893	-119.49523
2010	854.2438	2544.7654	190.04554
2011	744.0215	2198.8706	164.94878
2012	904.0277	2399.0856	442.28829
2013	647.9685	2113.0331	360.23219
2014	407.4575	1906.3750	174.76219
2015	280.7019	2077.5526	445.61794
2016	674.8833	1487.8878	160.83593
2017	386.1015	3831.4061	717.41375

Fig: 15 **Time series data values of Area, Yield and Production(anantapur district)**





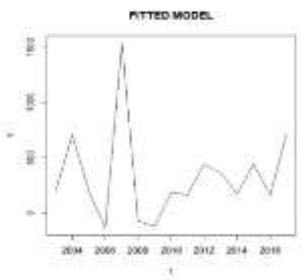


Table-7

Area, yield and Production Training Set error measure(ANANTAPUR DISTRICT)

	ARIMA	Trainng set error measures						
		ME	RMSE	MAE	MPE	MAPE	MASE	ACF
AREA	**(2,2,1)**	-39.32156	106.4165	78.72918	-7.747371	13.08958	0.5301628	-0.07247759
YIELD	**(1,1,2)**	88.62095	314.6438	232.736	1.447192	12.36299	0.4329972	-0.1178395
PRODUCTION	**(2,2,2)**	-15.73861	185.7466	138.9639	-41.75716	64.48948	0.4028773	0.03097403

III. CONCLUSIONS

AREA OF GROUNDNUT CROP CONCLUSION

Table-8
Identification of ARIMA(p,d,q) MODEL for AREA

Model	Area ARIMA	Coefficients	SE	Intercept	σ^2	Log likelyhood	AIC
(1,2,1)	**AR1**	-0.4942	0.2474		68501	-92.66	191.32
	MA1	-1.0000	0.2419				
(2,2,2)	**AR1**	-0.9584			18842	-85.51	181.01
	AR2	-0.8328	0.1101				
	MA1	-1.0457					
	MA2	0.2733					
(2,2,1)	**AR1**	-1.0433	0.1414		18311	-85.55	179.1
	AR2	-0.8656	0.1101				
	MA1	-0.8942	0.4141				
(0,2,1)	**MA1**	-1.0000	0.2229		94307	-94.22	192.44
(1,2,0)	**AR1**	-0.5541	0.2255		179063	-97.25	198.5
(2,1,2)	**AR1**	-1.1678	0.1220		26352	-92.53	195.06
	AR2	-0.9494	0.0856				
	MA1	0.7294	0.3841				
	MA2	0.4773	0.3684				
(2,0,2)	**AR1**	1.0555	0.4667	1163.4530	28207	-100.95	213.9
	AR2	-0.1345	0.4232	262.5888			
	MA1	-1.2608	0.4541				
	MA2	1.0000	0.3731				
(1,2,2)	**AR1**	-0.3732	0.2706		33640	-89.48	186.96
	MA1	-1.7125	0.3584				
	MA2	1.0000	0.3438				
(1,0,0)	**AR1**	0.4983	0.2347	1196.9099		-104.84	215.67
				127.2865			
(0,2,1)	**MA1**	-1.0000	0.2229		94307	-94.22	192.44

In the present study, the ARIMA (2,2,1) was 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(2,2,1) was 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, 2,1) 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 (2,2,1) model projected an increment in the area for the duration of 2018 to 2027. The prediction of 2027 is resulted approximately **82.490866'000 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.

YIELD OF GROUNDNUT CROP CONCLUSION

Table -9

Identification of ARIMA(p,d,q) MODEL for YIELD

MOdel	YIELD ARIMA	Coefficients	SE	Intercept	σ^2	Loglikelyhood	AIC
(1,1,2)	AR1	-0.1913	0.3489		106072	-103.9	215.81
	MA1	-1.7063	0.3099				
	MA2	1.0000	0.3459				
(1,1,1)	AR1	-0.5385	0.2846		189735	-105.89	217.78
	MA1	-0.7620	0.2077				
(2,0,1)	AR1	-1.1821	0.3422	1950.6812	135545	-110.36	230.73
	AR2	-0.6320	0.2377	57.6328			
	MA1	0.6241	0.3962				
(1,0,2)	AR1	0.0045	0.6424	1954.5356	137976	-110.52	231.04
	MA1	-0.7744	0.5841	80.3045			
	MA2	0.5315	0.3483				
(2,1,2)	AR1	-0.2839	0.3791		100430	-103.79	217.58
	AR2	-0.2011	0.3994				
	MA1	-1.6692	0.3587				
	MA2	0.9987	0.4041				
(0,0,1)	AR1	-0.4967	0.2502	1944.3853	164297	-111.5	228.99
				57.9525			
(1,0,0)	AR1	-0.5493	0.2827	1952.5571	161897	-111.42	228.85
				69.0038			
(2,1,1)	AR1	-0.9454	0.2799		142581	-104.25	216.49
	AR2	-0.6215	0.2576				
	MA1	-0.4880	0.3361				
(1,0,1)	AR1	-0.3982	0.4079	1944.3551	155125	-111.15	230.31
	MA1	-0.274	0.351	56.6366			
(2,0,2)	AR1	-0.7923	0.2059	1963.4142	98582	-109.63	231.26
	AR2	-0.8673	0.1609	72.8862			
	MA1	0.3770	0.2272				
	MA2	1.0000	0.3543				

In the present study, the ARIMA (1, 1 ,2) was the best fitted model 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, 1 ,2) was 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 (1,1 ,2) 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 (1,1,2) model projected an increment in the yield for the duration of 2018 to 2027. The prediction of 2027 is resulted approximately **2182.025** 'kg/ 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.

PRODUCTION OF GROUNDNUT CROP CONCLUSION

Table -10
Identification of ARIMA(p,d,q) MODEL for PRODUCTION

Model	PROD. ARIMA	Coefficients	SE	Intercept	$\sigma^{\wedge 2}$	Log likelihood	AIC
(0,2,2)	**MA1**	-1.6458	0.4275		258552	-102.03	210.07
	MA2	1.0000	0.4742				
(2,2,2)	**AR1**	-0.9486	0.4308		180643	-100.07	210.15
	AR2	-0.5499	0.3101				
	MA1	-1.0931	0.7358				
	MA2	0.0931	0.6721				
(2,0,2)	**AR1**	-0.5394	0.4920	891.2084	127034	-110.1	232.2
	AR2	-0.7691	0.3847	83.0299			
	MA1	0.2166	0.4661				
	MA2	0.8627	0.7988				
(2,1,2)	**AR1**	-1.0824	0.3979		159179	-104.57	219.13
	AR2	-0.5524	0.2456				
	MA1	-0.0685	0.4628				
	MA2	-0.2865	0.4034				
(1,2,2)	**AR1**	-0.3746	0.2700		161150	-100.7	209.41
	MA1	-1.9624	0.5258				
	MA2	0.9999	0.5274				
(0,0,2)	**MA1**	-0.4108	0.2435	889.4951	147861	-110.72	229.45
	MA2	0.3220	0.2615	89.1962			
(1,2,0)	**AR1**	-0.6588	0.1865		898777	-107.84	219.68
(2,0,0)	**AR1**	-0.3385	0.2499	892.4507	157684	-111.1	230.21
	AR2	-0.0739	0.2481	74.3219			
(2,2,1)	**AR1**	-0.9999	0.2089		183133	-100.08	208.17
	AR2	-0.5810	0.1956				
	MA1	-1.0000	0.2858				

In the present study, the ARIMA (2,2,2) was 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 (2,2,2) was 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 (2,2,2) 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, 2, 2) model projected an increment in the production for the duration of 2018 to 2027. The prediction of 2027 is resulted approximately **70.528254**

’000 tonnes. 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.

The empirical ***Forecasting area, yield, and production in Anantapur district : case of groundnut crop 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 Anantapur District .These empirical findings can be an important source of information to many researchers and policy formulators as far as agricultural crops in Anantapur District are concerned.

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