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Area, Production and Yield of Food Grains in India: A Time Series Approach

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ABSTRACT: *Food grains are cultivated in varying proportions in different parts of India based on its intensity and cropping pattern. It is worthwhile to know about the area, production and yield rate of food grains cultivated across the country over the years and also to forecast the future performance of these food grains by providing suitable forecasting methods. Data on food grains, about its area, production and yield for the period from 1962 -63 to 2018-19 are to be analysed by applying time series method. ARIMA is one such method which can be applied for time series data and by applying the Box-Jenkins methodology which is accepted worldwide would be an appropriate tool to forecast the performance of food grains in India. Diagnostics tests will be performed in order to ascertain the suitability of the model. This study would bring forth the government to take appropriate and necessary policy measures to sustain and disrupt the oscillating performance of food grains in India and also to take necessary steps to increase its overall performance.*
KEYWORDS: *food grains, ARIMA, Box-Jenkins, forecast.*

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I. INTRODUCTION:

The growth rate of agriculture production is generally judged by the performance of food grains and non-food grains production. From these both categories of agriculture production of food grain is more significant due to two reasons. Firstly, it provides the base for subsistence by supplying basic food items and secondly, it is the only group of agricultural produce where, Green Revolution was introduced firstly and more successfully. Its importance has also increased due to the inception of World Trade Organization (WTO) in 1995 and therefore in the present study we shall concentrate on agricultural production. At the time of independence agriculture occupied the most dominant place in the Indian economy by providing livelihood to about 70 percent of population and contributing about 48.6 percent of GDP (Sharma, P.N., 2005).

After the inception of Green Revolution, the scene has completely changed about the Indian agriculture which has transformed from food shortage to self reliance. This has become possible because of technological changes as well as the Government initiatives in form of various programmes. The new method of agricultural practice brought a drastic change in productivity and production. More and more agricultural land were brought under cultivation with the help of improved irrigation facilities (with the help of assured means of irrigation) cheaply available chemical fertilizers and supply of high yield varieties of seeds in the market. Farm mechanization has also shortened the period of plugging, sowing and harvesting process in agriculture. The implementation of land reforms has further added a new dimension to Indian agriculture. Therefore the successful implementation of Green Revolution and Land Reform not only increases the productivity but also increases the area under cultivation that paved the way for a higher growth in agricultural sector.

Constant economic growth, increasing population and varying lifestyles are causing significant changes in Indian food basket, away from staple food grains towards high value horticultural and animal products (Kumar et al., 2007; Mittal, 2007). While per capita consumption of food grains has declined, their total consumption has increased due to growing population. It varies in the dietary pattern towards animal products which has led to an increased demand for food grains. Nonetheless, food grains mainly rice and wheat continue to be the main pillars of India's food security (Praduman Kumar et al., 2007). On the supply side, inspired by the public investment in irrigation and rural infrastructure and rapid spread of high productive varieties of rice and wheat, together with enhanced crop production practices, India has achieved remarkable growth in food grain production. Total food grains increased from 827.1 Lakh tonnes during early-1962-1963s to 2849.5 Lakh tonnes by 2018-2019, Area under cultivation increased from 1178 Lakh hectares early-1962-1963s to 1239 Lakh hectares by 2018-2019 and Yield Per Hectare increased from 680kg/hectare early-1962-1963s to 2299kg/hectare by 2018-2019 (Hand book of Statistics on the Indian Economy-Department of Statistics and Information Management, Reserve Bank of India, 2018-2019).

Importance of the study:

India has high population pressure on land and other resources to meet its food and development needs. The natural resource base of land, water and bio-diversity is under severe pressure. Food demand challenges ahead are formidable considering the non-availability of favourable factors of past growth, fast declining factor productivity in major cropping systems and rapidly shrinking resource base. Vast uncommon opportunities to harness agricultural potential still remain, which can be tapped to achieve future targets. There are serious gaps both in yield potential and technology transfer as the national average yields of most of the commodities are low, which if addressed properly could be harnessed.

Concentration was on enhanced production of a few commodities like rice and wheat, which could quickly contribute to increased total food and agricultural production. This resulted in considerable depletion of natural resources and the rainfed dry areas having maximum concentration of resource poor farmers remained ignored, aggravating problems of inequity and regional imbalances. This also led to a high concentration of malnourished people in these rainfed, low productive areas. This era also witnessed rapid loss of soil nutrients, agro-biodiversity including indigenous land races and breeds. Keeping in mind this study tries to analyze the trend in area, production and yield in the overall food grains.

Related Studies:

Lasker Ershad Ali, Masudul Islam (2013) -'Forecasting Productions of Food Grain Using ARIMA Model and Its Requirement in Bangladesh'- Summarized that we forecast the food grain requirement and its production in Bangladesh. Before forecasting, we examine different methods and find time series model i.e. ARIMA model in different order predict accurate values. Then we used autoregressive integrated moving average (ARIMA) models to forecast the future amount of food grain in different years in this study. For the accuracy checking, we take the difference between the actual amount of food grain in a specific year and the predicted or the forecasting amount of the food grain in that year.

Rahul Tripathi, A.K. Nayak, R. Raja (2014) – 'Forecasting Rice Productivity And Production Of Odisha, India, Using Autoregressive Integrated Moving Average Models'- had studied that Forecasting of rice area, production, and productivity of Odisha was made from the historical data of 1950-51 to 2008-09 by using univariate autoregressive integrated moving average (ARIMA) models and was compared with the forecasted all Indian data. The autoregressive (p) and moving average (q) parameters were identified based on the significant spikes in the plots of partial autocorrelation function (PACF) and autocorrelation function (ACF) of the different time series. ARIMA (2, 1, 0) model was found suitable for all Indian rice productivity and production, whereas ARIMA (1,1,1) was best fitted for forecasting of rice productivity and production in Odisha. Predication was made for the immediate next three years, that is, 2007-08, 2008-09, and 2009-10, using the best fitted ARIMA models based on minimum value of the selection criterion, that is, Akaike information criteria (AIC) and Schwarz-Bayesian information criteria (SBC).

Mishra P., Sahu P,K., Padmanaban K., (2015) 'Study Of Instability And Forecasting Of Food Grain Production In India'- Stated that for food and nutritional security, forecasting production behaviours of the major food crops play vital role. Planners should have idea about the past and likely production scenario of the major crops. In this paper attempt has been made to examine the performance of total food grain production in India had its major states during the period (1950-2009). Stability in production behaviour with respect to areas production and yield of total food grains has been studied. This study also focuses on forecasting the area and production of total food grains in India using Autoregressive Integrated Moving Average (ARIMA) model. The success of agriculture depends on many factors from formulation of policy to its implementation, availability of inputs, climatic conditions etc. In an attempt to increase forecast accuracy, the study incorporated the factors of the factors of production in the ARIMA model as auxiliary variables. The study reveals that by and large estimated figures are closer to the observed figures when different factors are included in the model. Forecasting figures worked out using the best fitted ARIMA models with and or without the incorporation of 49455 thousand tonnes from an area of 19982 thousand hectare with 2718 kg/ha yield during year 2020.

Ashwini Darekar and Amarender Reddy A (2017), 'Forecasting of Common Paddy Prices in India', analysed that paddy is an important food crop in India and second most in the world. About 35% of net cropped area under paddy and about 50% of the farmers cultivate paddy every year. Farmer's decision making on acreage under paddy depends on the future prices to be realized during harvest period. Hence this paper presents a methodology to forecast process during harvest period and applied the method to forecast for the kharif 2017-18

A Dash, D S Dharke and D Bhattacharya (2017) – 'Forecasting of Food Grain Production in Odisha by Fitting Arima Model'-Examined that agricultural scenario of a state is reflected by the analysis of its food grain production status. In Odisha, food grains share a major portion of the total cropped area in kharif season and rabi. In kharif season, cereals from the major share of food whereas, in rabi the major share is by pulses. A time series modelling approach (B0x-Jenkins ARIMA model) has been used in this study to forecast food grain production in Odisha. The order of the best ARIMA model was found to be 2,1,0 for kharif food grain production and 1,1,0 and for rabi food grain production. The selected best fit models are also validated by using the data which were held up and not used for model building. Further, efforts were made to forecast, as accurate as possible, the future food grain production for kharif and rabi season for a period upto three years by using the best fit model. The forecast results have shown that the food grain production will show a positive growth from 2014-15 to 2016-17 for both kharif and rabi season. A Dash, DS Dharke and D Bhattacharya – 'Forecasting Of Food Grain Production In Odisha By Fitting ARIMA Model'

M. Hemavathi and K. Prabakaran (2018), 'ARIMA model for forecasting of area, production and productivity of rice and its growth status in Thanjavur district of Tamil Nadu, India'-had reported that crop acreage estimation and crop yield forecasting are two components, ,which are crucial for proper planning and policy making in the agriculture sector of the country. This research is a study model of forecasting area, production and productivity of rice in Thanjavur district as it is a "Rice bowl of Tamil Nadu". Data for the period of 1990-91 to 2014-15 were analyzed by time series methods. Auto correlation Function (ACF) and Partial Auto correlation Function (PACF) were calculated for the data. Appropriate Box Jenkins Auto Regressive Integral Moving Average (ARIMA) model was fitted. Validity of the model was tested using standard statistical techniques. For forecasting area, production and productivity ARIMA (0. 1, 2) (0, 1, 1) and (0, 1, 1) model respectively were used to forecast five leading years. The results also shows area forecast for the year 2020 to be about 158.15 thousand hectare with upper and lower limit 200.85 and 122.80 thousand heaters respectively, production forecast to be about 637.05 thousand tonnes with upper and lower limit 1057.63 and 216.47 thousand tonnes respectively and productivity forecast to be about 3.79 thousand kg per ha with upper and lower limit 5.83 and 1.75 thousand kg per ha respectively. The growth pattern was examined by fitting an exponential function (Y = AB). The result showed that the compound growth rate of rice was negative and non significant for area, production and yield for the study periods.

Pawan Kumar Sharma, Sudhakar (2018), 'Forecasting Maize Production In India Using ARMIA Model'-Analysed that forecasting is an important tool to estimate the area, production and productivity of any crop in near future. There are several methods available for foresting the future figures and autoregressive integrated moving average (ARIMA) is one of them. Maize is an important cereal of India, keeping in view its importance for rain fed areas of the country and diverse uses. The present study was conducted to forecast maize production for the year 2018 to 2022 based on the estimation of suitable ARIMA model. The analysis of ACF & PACF of differenced series revealed that ARIMA was the most suitable model for forecasting based on the diagnostics such as ACF, PACF, AIC, SBC etc. The selected ARIMA model predicted an increase of 13.76 percent increase in maize production next five years w.e.f. 2017 to 2022.

Bhola Nath, DS Dhakre (2019) – 'Forecasting Wheat Production In India: An Arima Modelling Approach'- Observed that Box-Jenkins' ARIMA model: A time series modelling approach has been used to forecast wheat production for India. ARIMA (1,1,0) model was found to be best ARIMA model for the present study. The efforts were made to forecast, by fitting ARIMA (1,1,0) model to our series data. The forecast results have shown that the annual wheat production will grow in 2026-27. The wheat production will continuously grow with an average growth rate of approximately 4 % year by year.

Objective of the study

To suggest an appropriate ARIMA model for analyzing the area, production and yield of food grains in India over a period of time.

Methodology

This study is based on secondary data obtained from 'Ministry of Agriculture and Farmers Welfare Government of India, published by Department of Statistics and Information Management, Reserve Bank of India, 2018-2019. The period of the study covers from 1962-63 to 2018-19. This study tries to analyses area, production and yield of food grains for the above mentioned years. Auto Regressive Integrative Moving Average (ARIMA) is a model fitted to the time series data in order to have capabilities to represent stationary as well as non-stationary time series for a single variable. This model is also known as Box Jenkins model which was introduced in 1960. While applying this model it is necessary to follow the steps involved in building this model. There are four steps i) Model identification ii) Parameter estimation and selection iii) Diagnostic checking and iv) Model's usage. For analysis of the data 'Eviews 9' software is used.

Estimated Model

AR (p) $Y_t = \alpha_o + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \alpha_3 Y_{t-3} + \ldots\ldots + \alpha_p Y_{t-p} + \varepsilon_t$

Where Y_t is the response variables at time t and $Y_{t-1}, Y_{t-2}, Y_{t-3} \ldots\ldots Y_{t-p}$ are the respective variables at different time with lags $\alpha_o, \alpha_1, \ldots\ldots \alpha_p$ are the coefficients and ε_t is the error factor and t is the time period. Similarly, the MA(q) model which is again the generalization of the moving average model can be written by

MA (q) $Y_t = \mu_t + \delta_1 Y_{t-1} + \delta_2 Y_{t-2} + \delta_3 Y_{t-3} + \ldots\ldots + \delta_q Y_{t-q} + \nu_t$

Where μ_t is the constant mean of the series and $\delta_1 \ldots \delta_q$ is the coefficients of the estimated error term ν_t.

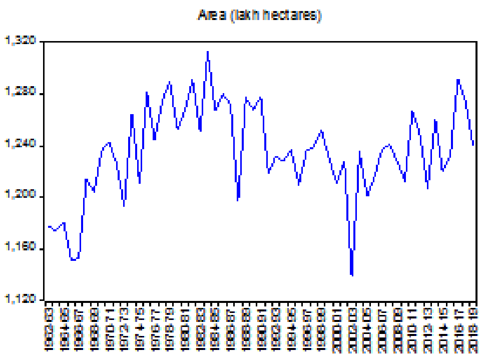
Combining both the equations the ARIMA model can be built under first order differentiation

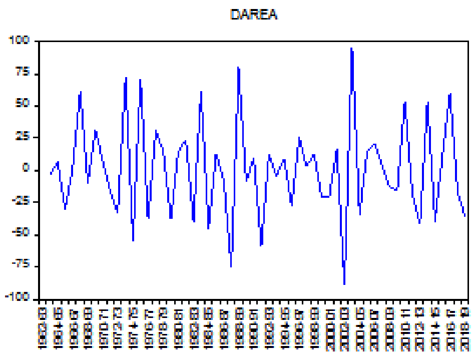
$Y_t = \alpha_o + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \alpha_3 Y_{t-3} + \ldots + \alpha_p Y_{t-p} + \varepsilon_t + \mu_t + \delta_1 Y_{t-1} + \delta_2 Y_{t-2} + \delta_3 Y_{t-3} + \ldots + \delta_q Y_{t-q} + \nu_t$

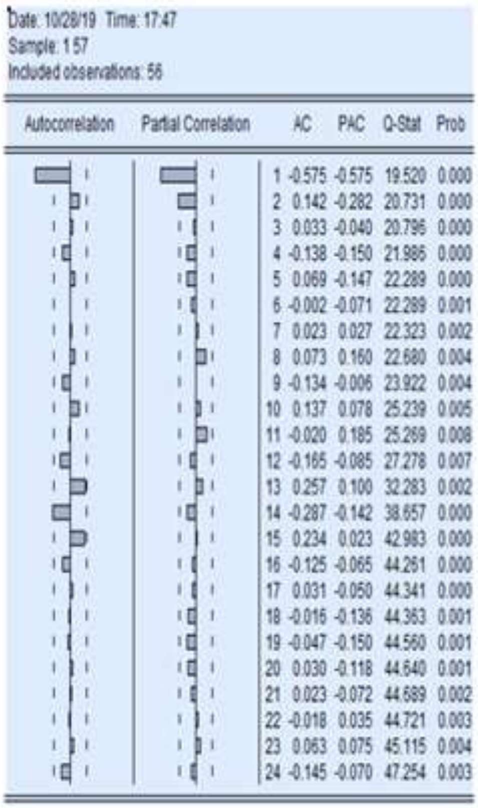
II. ANALYSIS AND INTERPRETATION

Area under Food grains

The first step in a ARIMA model building is to plot the data into a graph. After plotting the graph, it will give an insight of the nature of the data. So in this study the series of data have been plotted in a graph as it is shown below in the figure. It is clear from the graph that data is not stationary and it deviates more from mean and variance. So now it becomes necessary to make the data stationary because it is one of the preconditions of building a model using secondary data to make it stationary. For this purpose, differencing of data is applied starting with first order, if necessary, going for the second order differencing. After going for the first order differencing the data becomes stationary as it is shown in the figure below. Now the data after first order differencing is now suitable for building a model.







Date: 10/28/19 Time: 17:47
Sample: 1 57
Included observations: 56

	AC	PAC	Q-Stat	Prob
1	-0.575	-0.575	19.520	0.000
2	0.142	-0.282	20.731	0.000
3	0.033	-0.040	20.796	0.000
4	-0.138	-0.150	21.986	0.000
5	0.069	-0.147	22.289	0.000
6	-0.002	-0.071	22.289	0.001
7	0.023	0.027	22.323	0.002
8	0.073	0.160	22.680	0.004
9	-0.134	-0.006	23.922	0.004
10	0.137	0.078	25.239	0.005
11	-0.020	0.185	25.269	0.008
12	-0.165	-0.085	27.278	0.007
13	0.257	0.100	32.283	0.002
14	-0.287	-0.142	38.657	0.000
15	0.234	0.023	42.983	0.000
16	-0.125	-0.065	44.261	0.000
17	0.031	-0.050	44.341	0.000
18	-0.016	-0.136	44.363	0.001
19	-0.047	-0.150	44.560	0.001
20	0.030	-0.118	44.640	0.001
21	0.023	-0.072	44.689	0.002
22	-0.018	0.035	44.721	0.003
23	0.063	0.075	45.115	0.004
24	-0.145	-0.070	47.254	0.003

Dependent Variable: DAREA
Method: Least Squares
Date: 10/29/19 Time: 18:59
Sample (adjusted): 16 57
Included observations: 42 after adjustments
Convergence achieved after 18 iterations
MA Backcast: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.594838	0.159158	-3.737410	0.0006
AR(14)	-0.324495	0.095507	-3.397612	0.0016
MA(1)	-0.999827	0.046614	-21.44895	0.0000

R-squared	0.534909	Mean dependent var	-0.119048
Adjusted R-squared	0.511058	S.D. dependent var	39.42897
S.E. of regression	27.57046	Akaike info criterion	9.540116
Sum squared resid	29645.09	Schwarz criterion	9.664236
Log likelihood	-197.3424	Hannan-Quinn criter.	9.585611
F-statistic	22.42728	Durbin-Watson stat	1.829995
Prob(F-statistic)	0.000000		

Inverted AR Roots	.90+.21i	.90-.21i	.72+.58i	.72-.58i
	.40-.83i	.40+.83i	-.00+.92i	-.00-.92i
	-.40+.83i	-.40-.83i	-.72+.58i	-.72-.58i
	-.90+.21i	-.90-.21i		
Inverted MA Roots	1.00			

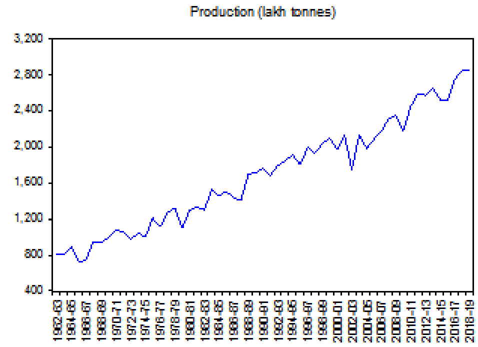
The next step is to find whether there is any unit root prevailing in the data. For this purpose, the Augmented Dickey Fuller test is applied in order to confirm that the data is stationary after first order differencing.

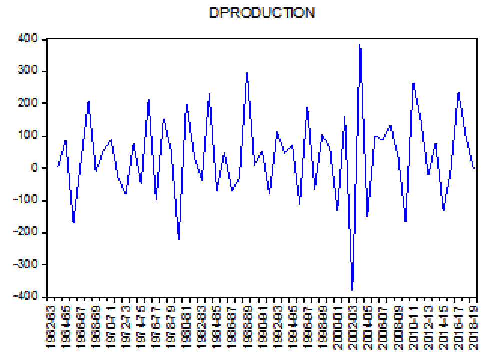
The auto correlation functions and the partial auto correlation functions of the first order difference for the area under food grains cultivation over the study are given in the above figure in the form of correlogram. The plots in the correlogram shows that after the first order difference the data becomes stationary because the spikes are not lying outside the confidence interval which is shown in the dotted lines.

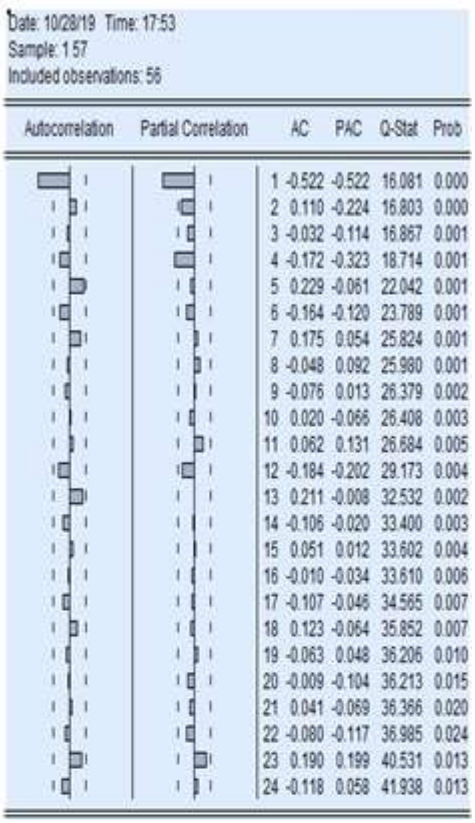
The constructed model is assessed and estimated based on the parameters estimated, the corresponding diagnostics of the residuals, the AIC and SIC model in order to select the best model for forecasting the future. Out of the alternate models for the area under food grains cultivation was ARIMA of (14,1,1). The result of the estimated output is presented in the table above. It is clear from the table that the model coefficients are significant based on the P value which is below 0.01 percent and all the inverted AR roots satisfy the minimum condition.

Production of Food grains

Production of Food grains the same procedure is repeated here for testing the data regarding the annual production of food grains over the years taken for the study. The data has been plotted in the form of graph for the actual data for the selected time period as shown in the figure below. It is clear from the graph below that there is an existence of non-stationary as the data shows inconsistency over the deviation from mean and variance. As stated earlier the data is brought into stationary for this purpose the data is differenced in the first order. The resultant graph of the differenced data is depicted in figure below and it is clear from the figure that the data becomes stationary in the second part.







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Sample: 1 57
Included observations: 56

	AC	PAC	Q-Stat	Prob
1	-0.522	-0.522	16.081	0.000
2	0.110	-0.224	16.803	0.000
3	-0.032	-0.114	16.867	0.001
4	-0.172	-0.323	18.714	0.001
5	0.229	-0.061	22.042	0.001
6	-0.164	-0.120	23.789	0.001
7	0.175	0.054	25.824	0.001
8	-0.048	0.092	25.980	0.001
9	-0.076	0.013	26.379	0.002
10	0.020	-0.066	26.408	0.003
11	0.062	0.131	26.684	0.005
12	-0.184	-0.202	29.173	0.004
13	0.211	-0.008	32.532	0.002
14	-0.106	-0.020	33.400	0.003
15	0.051	0.012	33.602	0.004
16	-0.010	-0.034	33.610	0.006
17	-0.107	-0.046	34.565	0.007
18	0.123	-0.064	35.852	0.007
19	-0.063	0.048	36.206	0.010
20	-0.009	-0.104	36.213	0.015
21	0.041	-0.069	36.366	0.020
22	-0.080	-0.117	36.985	0.024
23	0.190	0.199	40.531	0.013
24	-0.118	0.058	41.938	0.013

Dependent Variable: DPRODUCTION

Method: Least Squares

Date: 10/29/19 Time: 19:01

Sample (adjusted): 3 57

Included observations: 55 after adjustments

Convergence achieved after 15 iterations

MA Backcast: 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	36.50919	1.649254	22.13679	0.0000
AR(1)	0.165791	0.146392	1.132518	0.2626
MA(1)	-0.961949	0.044125	-21.80077	0.0000

R-squared	0.392636	Mean dependent var	37.14727
Adjusted R-squared	0.369276	S.D. dependent var	139.7582
S.E. of regression	110.9933	Akaike info criterion	12.30982
Sum squared resid	640614.9	Schwarz criterion	12.41931
Log likelihood	-335.5200	Hannan-Quinn criter.	12.35216
F-statistic	16.80795	Durbin-Watson stat	2.048648
Prob(F-statistic)	0.000002		

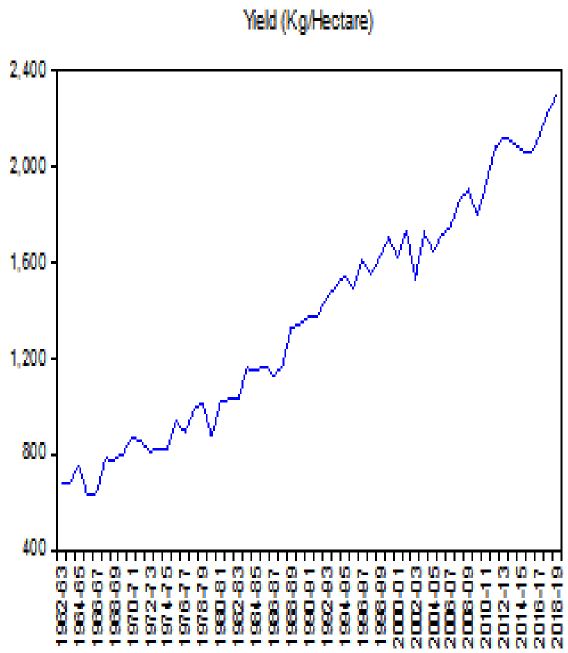
Inverted AR Roots	.17
Inverted MA Roots	.96

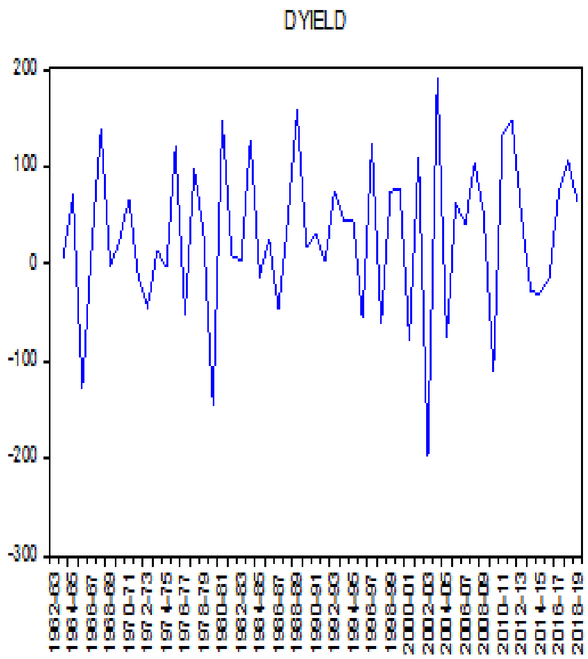
The correlogram of production of food grains after first order differentiation, it is clear that the DPRODUCTION becomes stationary and is of white noise as it shows no significant pattern in the correlogram and all the bars are lying within the confidence level. It is inferred that ARIMA (1,1,1) model will be suitable for the time series.

The constructed model is assessed and estimated based on the parameters given, the corresponding diagnostics of the residuals, the AIC and SIC model in order to select the best model for forecasting the future. Out of the alternate models for the production of food grains ARIMA of (1,1,1) was much suited and appropriate one.

Yield of Food grains

Yield of Food grains as stated earlier cotton is one of the premier cash crop in India existing over many number of civilization. Farmers from ancient time cultivate food grains mainly for extracting oil from it. In course of time the area under food grains started declining and also the production seems to be fluctuating but there was a slow and steady increase in the productivity of food grains. It was a major concern for the agricultural scientist and farmers. The data pertaining to yield rate exhibited an increasing trend over the years. In order to made it stationary the differentiation principle is applied and the results are shown in the form of graph as given below. The data after first order differentiation it is clear from the graph that after differentiation the data tends to become stationary and now it is fit for analyzing.





Date: 10/28/19 Time: 17:45
Sample: 1 57
Included observations: 56

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.425	-0.425	10.654	0.001
		2	0.043	-0.167	10.767	0.005
		3	-0.058	-0.136	10.977	0.012
		4	-0.143	-0.282	12.257	0.016
		5	0.218	0.018	15.287	0.009
		6	-0.173	-0.127	17.231	0.008
		7	0.232	0.133	20.796	0.004
		8	-0.055	0.132	20.997	0.007
		9	-0.077	0.031	21.406	0.011
		10	-0.064	-0.133	21.694	0.017
		11	0.133	0.160	22.970	0.018
		12	-0.167	-0.188	25.016	0.015
		13	0.154	0.026	26.811	0.013
		14	-0.009	0.031	26.817	0.020
		15	-0.083	-0.059	27.362	0.026
		16	0.089	-0.015	28.012	0.032
		17	-0.187	-0.037	30.924	0.020
		18	0.140	-0.109	32.602	0.019
		19	-0.010	0.058	32.611	0.027
		20	-0.062	-0.081	32.954	0.034
		21	0.090	-0.029	33.708	0.039
		22	-0.151	-0.121	35.877	0.031
		23	0.190	0.182	39.439	0.018
		24	-0.043	0.065	39.629	0.023

Dependent Variable: DYIELD

Method: Least Squares

Date: 10/29/19 Time: 19:03

Sample (adjusted): 3 57

Included observations: 55 after adjustments

Convergence achieved after 15 iterations

MA Backcast: 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	29.55643	1.474532	20.04461	0.0000
AR(1)	0.374019	0.141488	2.643460	0.0108
MA(1)	-0.958769	0.051441	-18.63823	0.0000

R-squared	0.286701	Mean dependent var	29.30909
Adjusted R-squared	0.259266	S.D. dependent var	81.36791
S.E. of regression	70.03002	Akaike info criterion	11.38873
Sum squared resid	255018.6	Schwarz criterion	11.49822

Log likelihood	-310.1900	Hannan-Quinn criter.	11.43107
F-statistic	10.45033	Durbin-Watson stat	2.120687
Prob(F-statistic)	0.000153		
Inverted AR Roots	.37		
Inverted MA Roots	.96		

The result of the estimated output is presented in table above. It is clear from the table that the model coefficients are significant based on the P value which is below 0.01 percent and all the inverted AR and MA roots satisfy the minimum condition. Also, the Durbin-Watson statistics is nearing 2 the optimum threshold which implies that there is no serial correlation in the model residual.

The constructed model is assessed and estimated based on the parameters taken, the corresponding diagnostics of the residuals, the AIC and SIC model in order to select the best model for forecasting the future. Out of the alternate models for the productivity of cotton ARIMA of (1,1,1) is suitable and appropriate one.

III. CONCLUSION

In this study the model developed for analysis was ARIMA (14,1,1) for area under food grains and for production and yield of food grains ARIMA (1,1,1) was applied. The production and productivity of the different food grain crops have increased during the period under review due to the combined effects on area, production and productivity. In addition to that, productivity can be further increased by adopting appropriate technologies. In light of these findings, following suggestions are recommended for formation of appropriate policies.

It is a general observation that growth in productivity of food grain crops is skimpy because of poor availability of HYV seeds, wide spread infestation of pest and diseases, destruction of crops by wild animals, inadequate and irregular water supply, etc. Therefore, steps should be taken to overcome these difficulties faced by the cultivators at the field level. A rising growth trend associated with high degree of variability is a sign of vulnerability in the growth process. Wide spread ups and downs in area, production and yield of food grain crops shatters the rational expectations of the cultivators and leads to many disruptive consequences. This inference can be used by the government to take necessary steps to avoid fluctuations in the area and production of food grains and also to implement suitable policies to upgrade the yield of food grains.

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