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Research Article – Agriculture

Forecasting Major Food Crops Production in Khyber Pakhtunkhwa, Pakistan

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Abstract

The present study was undertaken toinvestigateforecasting of major foodcrops production in Khyber Pakhtunkhwa. The study was based on secondary data covers a period of about 30 years i.e. starting from 1984-85 to 2013-14, whereas, ARIMA modeling has been employed to fit the best time series modelfor major food crops production i.e. wheat, maize, sugarcane and rice. It reveals through the results that for major food crops production, the time series models which were found to be most suitable are as ARIMA (0, 2, 1), ARIMA (1, 2, 3), ARIMA (0, 2, 1) and random model ARIMA (0, 1, 0) respectively based on forecast evaluation criteria. It was concluded from the results of analyzed data thattime series models were found adequate for forecasting major food crops production in Khyber Pakhtunkhwa.

Key words: Forecast Evaluation Criteria, Diagnostics Measures, ARIMA Modeling, Parameter Estimates, ADF test

Introduction

Agriculture sector plays significant role in the economy of each and every country. Agriculture occupies central position in Pakistan and contributes nearly 20.9% to the GDP and about 43.5% of the labor force is engaged in agriculture (Pakistan Economic Survey, 2014-2015). Agriculture sector contributes significantly in the economy of Pakistan and also considered as the largest sector as well as the hub of economic activities. With the increase in the growth rate of population, it was found to be slowed down i.e. over 3% in 1980's, while, during the year 2012-13, it was reported to be 2% which was still comparatively high. Moreover, It was reported that in the scenario of current rate of increase in the population growth, it can be expected that Pakistan will attain fifth position from current running status of sixth most populous country in the world ranking by the year 2050 (Government of Pakistan, 2013).

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Maize food crop is an enriched food as compared to other food crops. The share of maize was 2.1 percent to the value addition in agriculture sector and 0.4 percent to the GDP of Pakistan in 2013-14. Also, wheat is the most important food crop of Pakistan which contributes 10.3 percent to the value addition in agriculture and 2.2 percent to GDP. Similarly, sugarcane is one of the major and high value cash crops of Pakistan. It is very crucial for sugar production. The share of sugarcane was 3.4 percent in agriculture value addition in 2013-14 and 0.7 percent in GDP. Moreover, among the food crops rice is a very important food and cash crop of Pakistan. It is the second staple food grain of Pakistan after wheat and also the main source of foreign exchange earnings after cotton. It contributes 3.1 percent of the value added in agriculture and 0.7 percent in the GDP of Pakistan.Ahmad and Mustafa (2006) developed an econometric model for the purpose of forecasting exports potential of Kinnow from Pakistan using time series data (1990-91 to 2002-03) for the year through 2023. They established the ARIMA (2, 2, 2) which was found suitable model for forecasting and also concluded that the measure of increase in production of Kinnow contributes large amount of share of

Pakistan in the internationally sound markets. Mehmood (2012) used uni-variate model to forecast the exports of Pakistan to SAARC and argued that the ARIMA model was found suitable one for forecasting time series data. Similarly, ARIMA model technique has also been used widely in literature for forecasting purpose. Furthermore, Efforts have also been made to estimate production and productivity of sugarcane using ARIMA models (Yaseen et al., 2005; Bajpai and Venugopalan, 1996). Also, attempt regarding ARIMA models including forecasting of sugarcane production in Pakistan (Muhammad et al., 1992), forecasting of area, production and productivity of different crops for Tamilnadu State (Balanagammel et al., 2000), forecasting of wheat production in Canada and Pakistan (Boken, 2000; Saeed et al., 2000), forecasting agricultural production at state level (Indira and Datta, 2003), estimating sugarcane area and yield for Pakistan (Masood and Javed, 2004), estimating and modeling of wheat yield in Pakistan (Ullah et al., 2010), sugarcane yield estimation for Tamilnadu (Suresh and Krishnaprya, 2011), and predicting productivity in India (Padhan, 2012).

Material and Methods

The present study is conducted by using time series data with effect from 1984-85 to 2013-14 i.e. time series data of 30 years, to forecast production for onward ten years regarding major food crop including wheat, maize, sugarcane and ricein Khyber Pakhtunkhwa, Pakistan. The time series data were collected from secondary sources of various issues of Crop Statistics, Crop Reporting Service of Khyber Pakhtunkhwa and were analyzed in Statistical Package Gretl1.9.4.

Analytical Techniques

Generally, ARIMA model technique has extensively been employed in literature to forecast the specific area as well as production related to different major crops (Munir, 2008; Gujrati, 2003).

Autoregressive Integrated Moving Average (ARIMA)

ARIMA model is a generalized form of ARMA model introduced by Box and Jenkins (1976) which includes both autoregressive as well as moving average parameters, and also includes the differencing in the formulation of this model. ARIMA model is summarized as ARIMA (p, d, q). In ARIMA (p, d, q) model where p, d and q are the non-negative integers referred to as the order of the autoregressive integrated moving average process. It is an important part of Box Jenkins approach to time series modeling. It can be written as;

$$\Delta^d Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_p Y_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \cdots + \beta_q \varepsilon_{t-q} \quad \text{-------(1)}$$

Where, Δ^d represents differencing of order d i.e. $\Delta Y_t = Y_t - Y_{t-1}$, $\Delta^2 Y_t = \Delta Y_t - \Delta Y_{t-1}$ and so forth, $Y_{t-1} \dots Y_{t-p}$ shows lags of the variables.

Stationary Test

The first step in Box- Jenkins methodology is to find whether data is stationary or not. There are a number of tests which can be used to decide about the stationary of the variables. Augmented – Dickey Fuller (1981), abbreviated as ADF, is the more popular test in literature due to its simplicity and powerfulness.

Mathematically,

$$\Delta y_t = a_0 + \lambda y_t + a_1 t + \sum_{i=1}^{p} \beta_i y_{i-1} + e_t \quad \text{---------(2)}$$

There are three options in this equation

- a_0 is the intercept or drift parameter of the time series.
- t is the time trend in time series. There may be downward or upward linear trend in the data.
- It is also possible that both drift and time trend exist in the data.

Diagnostic Measures for Selection of Best Forecasting Model

There are few diagnostic checks which each estimated model has to fulfill and are as follows;

- Residuals are normally distributed
- The corresponding projected model is stable
- Residuals of the projected model are not serially correlated

a) The Q- Statistic

The Q-Statistic is used to test whether the set of autocorrelation is significant i.e. diverse from zero. Box and Pierce (1970) make use of sample autocorrelation to form the statistics.

$$Q = T \sum_{k=1}^{s} r_k^2 \quad \text{------------(3)}$$

In the hypothesis testing procedure, the null hypothesis is that every values of r_k=0, and Q has asymptotically χ^2 distributed with s degrees of freedom. Moreover, it is better to use Ljung-Box (1978) in case of small samples in support of modified Q-statistic designed as;

$$Q = T(T+2)\sum_{K=1}^{S} r_k^2 / T-K \quad \text{----------(4)}$$

It has χ^2distribution with sdegree of freedom.

b) Jarque-Bera Test

To check the normality of residuals Jarque-Bera (1978) test is used. It is based on the fact that skewness and kurtosis of normal distribution are equals to zero. The corresponding test therefore an absolute value of these parameters and a measure of deviation from normal distribution. The Jarque-Bera statistic is calculated as follows;

$$Jarque - Bera = \frac{N-P}{6}\left[S^2 + \frac{(K-3)^2}{4}\right] \quad \text{-----------(5)}$$

Where S and K represents skewness and kurtosis respectively, of the distribution while, p denotes estimated coefficients involved in the Jarque- Bera statistic, having asymptotic χ^2distributionwith "2" degree of freedom.

Model Selection Criteria

Generally, the model selection criteria statistics are used to compare the fits of different forecasting and smoothing method and also contributes a great deal of information by comparing the fits obtained through different methods. These measures including Akaike information criteria (AIC) and Schwartz information criteria (SIC). Smaller values of these accuracy measures indicate a good fitted model with minimum forecasting error (Karim*et al*. 2010).

Results and Discussions

1.1 ARIMA Modeling for Wheat Crop Production

At first, it is very essential to find out the stationarity of the data for wheat crop production. It is important to consider that which order difference of time series sequence of wheat crop production satisfies the stationarity conditions. The Dickey fuller unit root test is performed and plot of time series of wheat crop production and is shown in Figure-1.1 and Figure -1.2.

From the results of dickey fuller test it can be showed that the original series is non-stationary as there is a unit root in the data presented in Table-1.1.

Figure 1.1. Graph of Original series for Wheat crop production

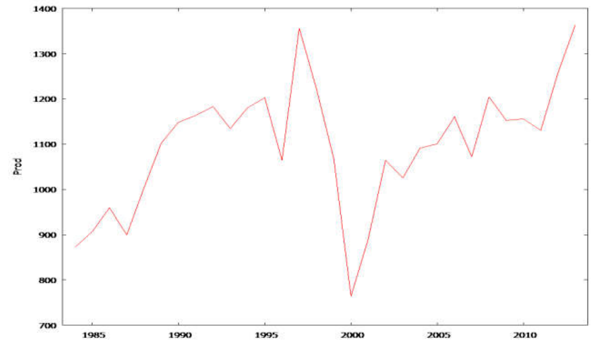


Figure 1.2. Graph of Ist Order difference series for Wheat crop production

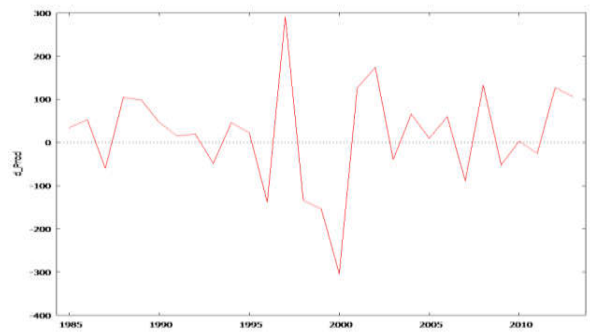
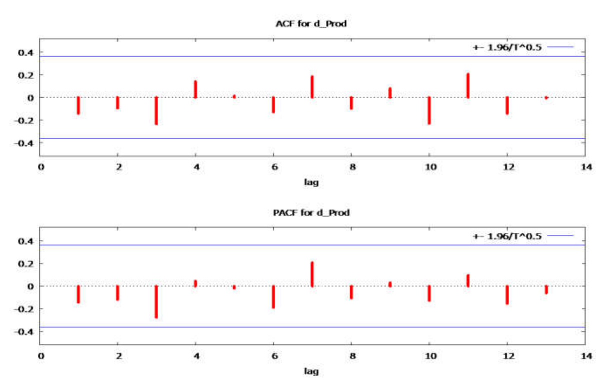


Table 1.1. Augmented Dickey Fuller Test for Wheat crop Production

Production Series	Null hypothesis	P-Value	Remarks
Original series	a=1	0.1512	Non-Stationary
Ist order difference	a=1	0.00004374	Stationary

By taking first difference, it is found that stationarity condition is satisfied with the p-value =0.000044, which strongly suggests that there is no unit root.

Figure 1.3. ACF & PACF Plot of Ist order difference series for wheat crop Production



Moreover, it is clear from ACF & PACF of the differenced series that a tentative selected ARIMA model to forecast the wheat crop production in Khyber Pakhtunkhwa is ARIMA (0, 2, 1). Based on the Accuracy measures, it is obvious that ARIMA (0, 2, 1) is an adequate model for wheat crop production at 5% level of significance. The best selected model has smallest AIC and SIC's among all possible subset models.

Table 1.2. Presents model parameter estimates along with their significance

Table 1.2. ARIMA (0, 2, 1) Model using observations 1986-2013 (t = 28) Dependent variable: Second order Difference for wheat crop Production

Coefficient	**Std. error**	**Z**	**P-value**
const0.311069	2.62655	0.1184	0.9057
theta_1 -1.00000	0.105667	-9.464	2.97e-021 ***
Mean dependent var2.539286	S.D. dependent var	177.9415	
Mean of innovations -7.166388	S.D. of innovations	116.1125	
Log-likelihood -174.5416	Akaike criterion	355.0832	
Schwarz criterion 359.0798	Hannan-Quinn	356.3050	

1.2. Model Diagnostics

To check the auto correlation assumption, the "Ljung-Box" test is used. Test statistic gives Q' = 15.55, with p-value = 0.556, which suggests that we may accept the assumption that there is no autocorrelation among the residuals of the fitted ARIMA model at 5% level of significance. To check the normality assumption, the JarqueBera test is used resulting test statistic value = 0.690693, with p-value 0.707975, which suggests that normality assumption of the residuals is valid. Graphical residuals diagnostics are shown in Figure-1.4 and Figure-1.5.

Figure 1.4. Q-Q Plot of Residual

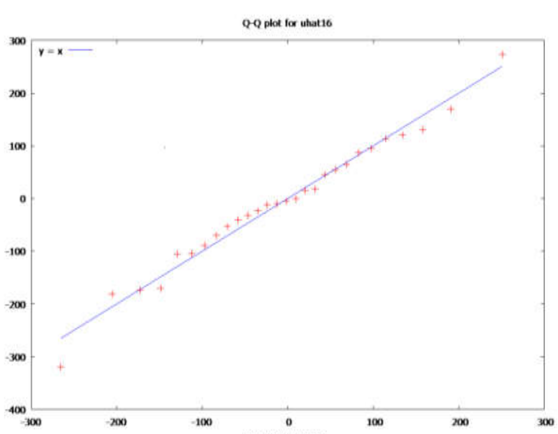
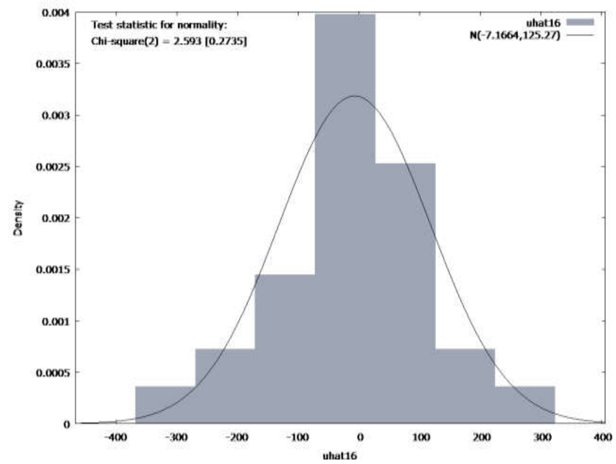


Figure 1.5. Histogram of Residual



The Q-Q plots and histogram of residuals also show normality. So, it can be concluded from the graphical and formal tests that the selected model ARIMA (0, 2, 1) is and adequate model to forecast wheat crop production in Khyber Pakhtunkhwa.

1.3. Forecast for Wheat Crop Production

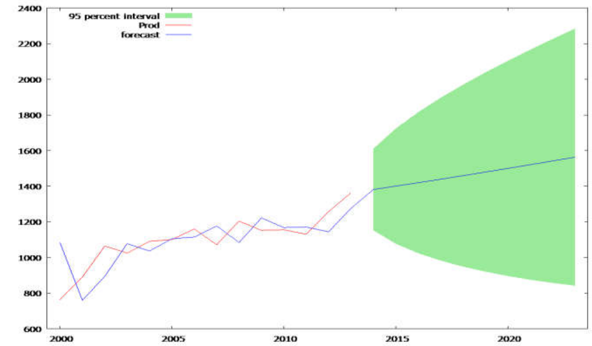
The selected model is used for forecasting the wheat crop production. In Table-3, the predicted values, standard errors, lower and upper confidence limits for ten years onward values are given, for Khyber Pakhtunkhwa based on the sample data.

Table 1.3. Forecast for Wheat Crop Production with effect from 2014-2023

Year	Predicted production	Std. Error	95% interval
2014	1381.7	116.11	1154.1 - 1609.3
2015	1400.6	164.21	1078.7 - 1722.4
2016	1419.8	201.11	1025.6 - 1814.0
2017	1439.3	232.22	984.2 - 1894.5
2018	1459.2	259.64	950.3 - 1968.0
2019	1479.3	284.42	921.9 - 2036.7
2020	1499.8	307.20	897.6 - 2101.9
2021	1520.5	328.42	876.8 - 2164.2
2022	1541.6	348.34	858.9 - 2224.3
2023	1563.0	367.18	843.3 - 2282.7

By comparing the original and forecasted series it is obvious that the original series of wheat crop production shows increasing tendency with the passage of time and following the same pattern in the next stages and finally showing increasing pattern. Similarly the forecasted series shows the same pattern. In the forecast plot the in sample and out sample forecasting part is shown in Figure-1.6.

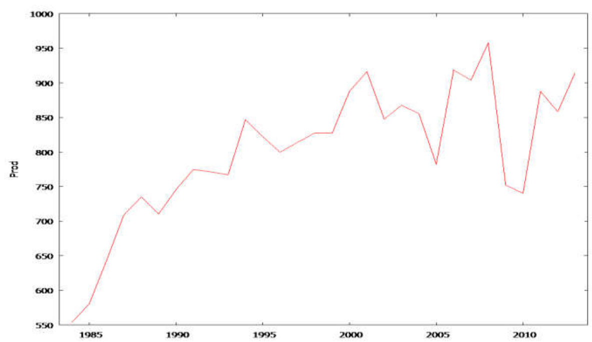
Figure 1.6. Forecast plot for wheat crop Production



2.1 ARIMA Modeling for Maize Crop Production

Firstly, it is important to check the stationarity of the series by using Dickey fuller unit root test. Also, it is worthwhile to consider that which order difference of time series sequence of maize crop production satisfies the stationarity conditions. The time series plots of maize crops production are as shown in Figure-2.1.

Figure 2.1. Graph of original series for Maize crop Production



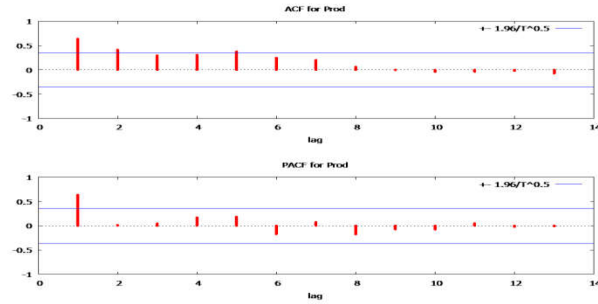
By Augmented dickey fuller unit root test, it is evident that the original series of maize crop production show stationarity. The detail results of Augmented dickey fuller unit root test are presented in Table-2.1.

Table 2.1. Augmented Dickey Fuller Test for Maize Crop Production

Production Series	Null hypothesis	P-value	Remarks
Original Series	a=1	0.002894	Stationary

In Figure-2.2, it is clear that from the ACF and PACF plot, a tentative selected ARIMA model to forecast the maize crop production in Khyber Pakhtunkhwa is ARIMA (1, 2, 3).

Figure 2.2. ACF & PACF Plot for Original Maize Crop Production



Among various fitted models, ARIMA (1, 2, 3) is found to be the best model for forecasting citrus fruit production in Khyber Pakhtunkhwa. The selected model has the smallest AIC and SIC.

Table 2.2. presents model parameter estimates along with their significance

Table 2.2. ARIMA (1,2,3) Model using observations 1986-2013 (t = 28) Dependent variable: Original Maize Crop Production

Coefficient		Std. Error	Z	P-value
const	-1.23669	0.257034	-4.811	1.50e-06 ***
phi_1	-0.605755	0.351369	-1.724	0.0847 *
theta_1	-1.15384	0.288459	-4.000	6.33e-05 ***
theta_2	-0.646992	0.465896	-1.389	0.1649
theta_3	0.830143	0.272665	3.045	0.0023 ***
Mean dependent var	1.067857	S.D. dependent var	104.8328	
Mean of innovations	-9.455098	S.D. of innovations	49.64575	
Log-likelihood	-153.6890	Akaike criterion	319.3779	
Schwarz criterion	327.3712	Hannan-Quinn	321.8215	

2.2. Model Diagnostics

Furthermore, that Ljung- Box Q' =12.08, with p-value = 0.600. This suggests that there is no autocorrelation among the residuals of the fitted ARIMA model at 5% level of significance. To check the normality assumption, "Jarque-Bera" test is used. The Jarque-Bera test = 3.00534 having p-value = 0.222535, which indicates that the normality assumption of the residuals is valid.

Figure 2.3. Q-Q Plot of Residual

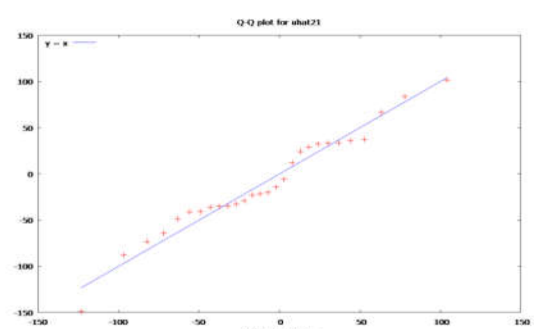
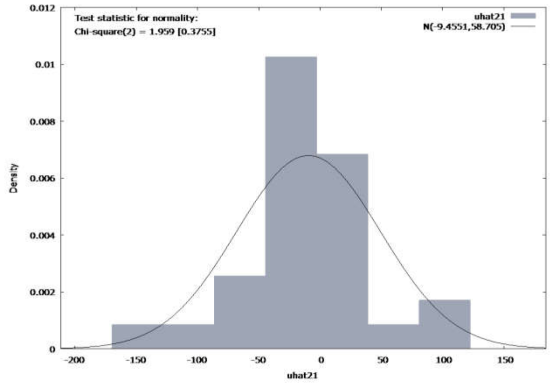


Figure 2.4. Histogram of Residual



The Q-Q plot and histogram of residuals in Figure-2.3 and Figure-2.4 show picture of approximate normality for residuals. Thus our fitted model ARIMA (1, 2, 3) is an adequate model for forecasting maize crop production in the Khyber Pakhtunkhwa.

2.3. Forecast for Maize Crop Production

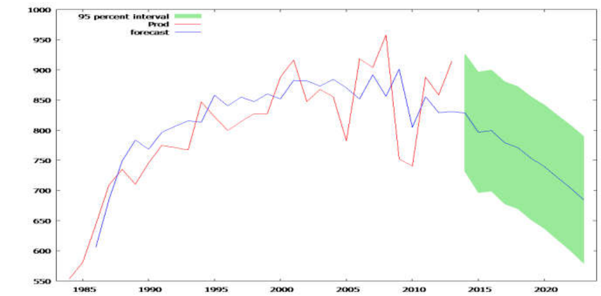
After selecting the best fitted model the next stage is to forecast maize crop production for onward ten years based on the available sample data. Also, the predictions, standard error, lower and upper confidence limits for onward ten year are given in Table-2.3.

Table 2.3. Forecast for Maize Crop Production with effect from 2014-2023

Year	Predicted production	Std Errors	Conf. Interval
2014	828.5	49.65	731.2 - 925.8
2015	796.6	51.06	696.6 - 896.7
2016	799.4	51.30	698.9 - 900.0
2017	779.3	51.74	677.9 - 880.7
2018	771.0	51.75	669.6 - 872.5
2019	753.6	52.09	651.5 - 855.7
2020	739.7	52.28	637.2 - 842.2
2021	721.7	52.73	618.3 - 825.0
2022	704.2	53.17	600.0 - 808.4
2023	684.4	53.81	578.9 - 789.9

Moreover, it is also possible to compare the original and predicted citrus production graphically as given in Figure-2.5. In the forecasted plot, in sample and out sample forecasting parts are shown. The original maize crop production shows initially up-ward tendency but with the passage of time it shows downward tendency. The forecast for maize crop production represents generally a downward tendency in the onward time period of ten years.

Figure 2.5. Forecast plot for Maize Crop Production



3.1. ARIMA Modeling for Sugarcane Crop Production

The time series plot for sugarcane production is presented in Figure-3.1 and Figure-3.2, indicates trend in data and does not show constant mean and variance over time i.e. up-ward trend initially and then down-ward trend in the end which indicates non-stationarity. The first order difference of the data makes the series stationary.

Figure 3.1. Original series of Sugarcane production

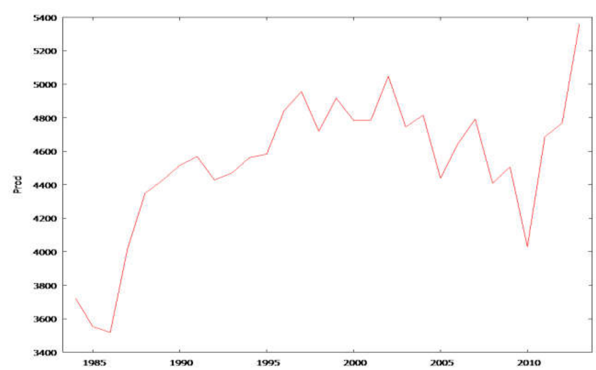
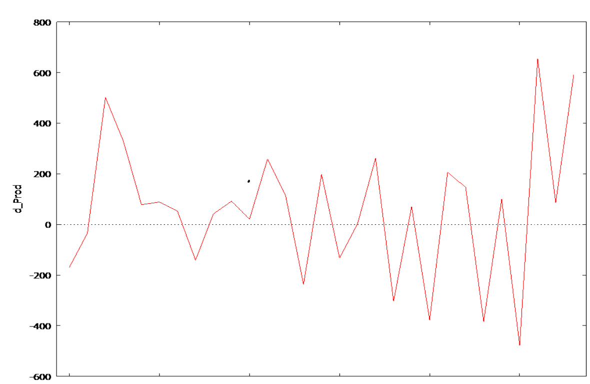


Figure 3.2. Ist order difference Sugarcane production



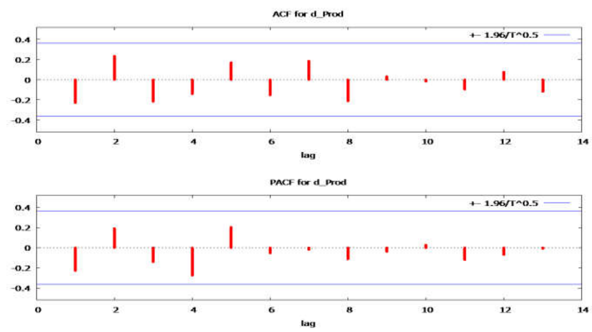
The results of Dickey fuller unit root test, show stationarity at first order difference as its p-value = 0.013288, which suggest that there is no unit root at first order difference and have constant variance as shown in Table-3.1.

Table 3.1. Augmented Dickey Fuller Test for Sugarcane Production

Production Series	Null hypothesis	P-value	Remarks
Original Series	a=1	0.3375	Non-Stationary
I^{st} order difference	a=1	0.01388	Stationary

The tentative model based on ACF and PACF plot are given in Figure-3.3 is ARIMA (0, 2, 1).

Figure 3.3. ACF & PACF Plot of first Order difference series for Sugarcane Production



Also, various neighbor models when fitted give the best fitted model as (0, 2, 1) having lowest accuracy measures i.e. AIC and SIC's as compared to other subset models.

Table 3.2. Presents model parameter estimates and their significance

Table 3.2. ARIMA(0,2,1) Model using observations 1986-2013 (t= 28) Dependent variable: Second Order Difference for Sugarcane Crop Production			
Coefficient	**Std. error**	**Z**	**P-value**
const 0.226996	5.90897	0.03842	0.9694
theta_1-1.00000	0.119297	-8.382	5.19e-017 ***
Mean dependent var 27.16071	S.D. dependent var	419.5145	
Mean of innovations 4.598371	S.D. of innovations	272.4758	
Log-likelihood	-198.4253	Akaike criterion	402.8506
Schwarz criterion	406.8473	Hannan-Quinn	404.0724

3.2. Model Diagnostics

The Ljung- Box test Q' = 11.5 has p-value= 0.830 clearly suggests that there is no autocorrelation among the residuals of the fitted ARIMA model at 5% level of significance. By applying Jarque-Bera normality test of residuals it is found thatJarque-Bera test = 4.37 has p-value = 0.1123 which indicates that the normality assumption of residuals is valid.

Figure 3.4. Q-Q Plot of Residual

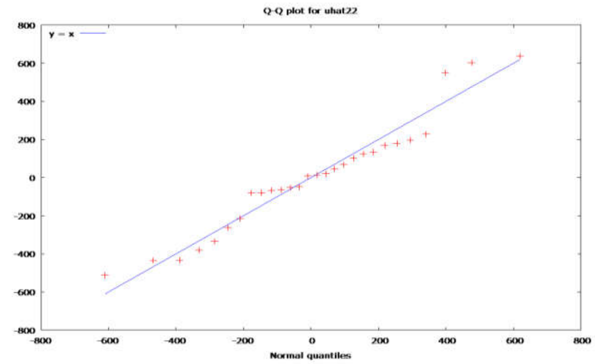
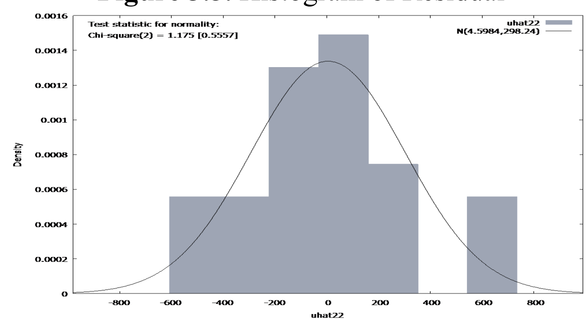


Figure 3.5. Histogram of Residual



The Q-Q plot and histogram in Figure-3.4 and Figure-3.5 show picture of approximate normality for residuals. Thus our fitted model ARIMA (0, 2, 1) is an adequate model for forecasting Sugarcane production in Khyber Pakhtunkhwa.

3.3. Forecast for Sugarcane Production

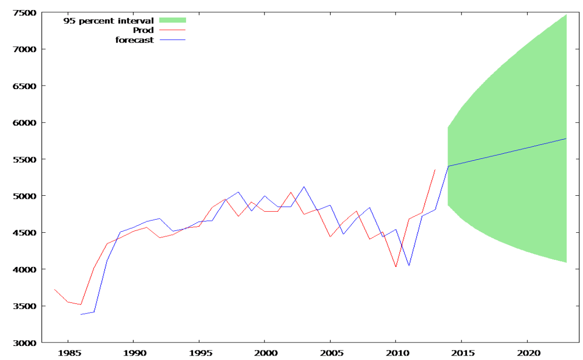
The selected model is used to forecast the sugarcane production for onward period of ten years i.e. from 2014 to 2023. The predicted values, standard errors, lower and upper confidence limits are presented in Table-3.3.

Table 3.3. Forecast for Sugarcane Production with effect from 2014-2023

Year	Prediction	Std. Error	Confidence interval
2014	5402.3	272.48	4868.3 - 5936.4
2015	5443.5	385.34	4688.3 - 6198.8
2016	5484.9	471.94	4559.9 - 6409.9
2017	5526.5	544.95	4458.4 - 6594.6
2018	5568.4	609.27	4374.2 - 6762.5
2019	5610.4	667.43	4302.3 - 6918.6
2020	5652.7	720.90	4239.8 - 7065.7
2021	5695.3	770.68	4184.8 - 7205.8
2022	5738.0	817.43	4135.9 - 7340.2
2023	5781.0	861.64	4092.2 - 7469.8

Moreover, it is possible to compare the original and predictions for sugarcane production are graphically given in Figure-3.6. By comparing the original and forecasted sugarcane production, it is quite clear that sugarcane production shows upward production tendency and the forecasted series also shows the same upward production tendency. The in-sample and out-sample forecasting shows same pattern for forecasting sugarcane production in Khyber Pakhtunkhwa.

Figure 3.6. Forecasting Plot for Sugarcane Production



4.1. ARIMA Modeling for Rice Production

The original time series graph is shown in Figure-18 indicates trend in data and does not show constant mean and variance over time. It shows upward trend initially and then downward trend with the passage of time, and finally shows increasing trend which indicates non-stationarity in the data.

To check the stationarity of data, Dickey fuller unit root test is used. From the dickey fuller test it is evident that stationarity condition is not satisfied for original rice crop production series as presented in Table-4.1.

Figure 4.1. Original series of Rice production

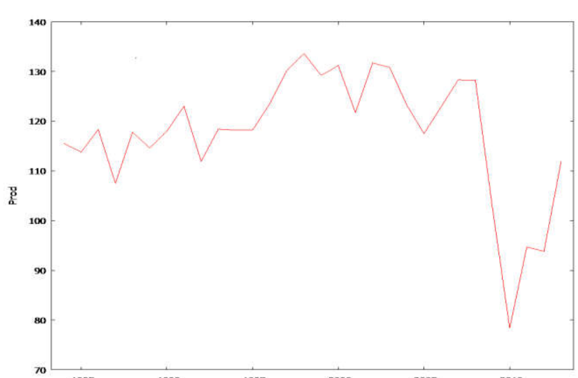


Figure 4.2. Ist order differenced series of Rice production

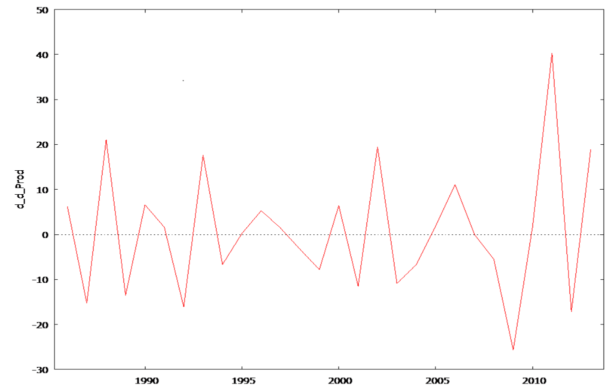
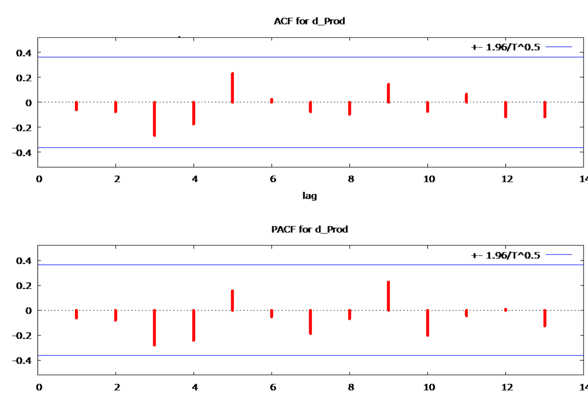


Table 4.1. Augmented Dickey Fuller Test for Rice Production

Production Series	Null hypothesis	P-value	Remarks
Original Series	a=1	0.7104	Non-stationary
Ist order difference	a=1	0.0436	Non-stationary

By first order differencing, it is found in Figure-4.3, that stationarity is achieved with the p-value = 0.0436, which suggests that there is no unit root at first order difference for rice production. So, it is obvious that at first order difference the series has become stationary.

Figure 4.3. ACF and PACF Plot of Ist Order Difference of Rice Production



From the tentative analysis, the selected ARIMA model to forecast the rice production in Khyber Pakhtunkhwa is random model ARIMA (0, 1, 0) on the basis of forecast evaluation criteria.

Table 4.2. Presents model parameters summary along with their significance

Table 4.2. ARIMA(0,1,0) model using observations 1985-2013 (t = 29) Dependent variable: First Order Difference for Rice Production

Coefficient	Std. error	Z	P-value
const -0.124138	1.83729	-0.06757	0.9461
Mean dependent var -0.124138	S.D. dependent var 9.894106		
Mean of innovations 1.44e-18	S.D. of innovations 9.894106		
Log-likelihood -107.1066	Akaike criterion 216.2133		
Schwarz criterion 217.5806	Hannan-Quinn 216.6415		

4.2. Model Diagnostics

To check out the Auto correlation assumption the "Ljung-Box" test is used. From the test it is found that Ljung-Box Q'= 11.70 with p-value = 0.863, which suggests that there is no autocorrelation among the residual of the fitted ARIMA model at 5% level of significance. To check the normality assumption, JarqueBera test is used. The Jarque-Bera test =3.97 having p-value =0.1362, which indicates that normality assumption of the residuals is valid. Graphical representation of residuals diagnostics are shown in Figure-4.4 and Figure-4.5.

Figure 4.4. Q-Q Plot of Residual

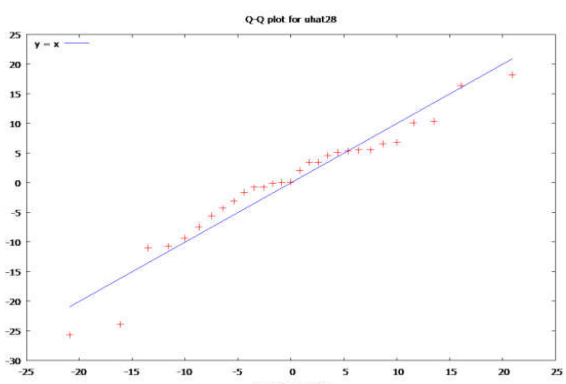
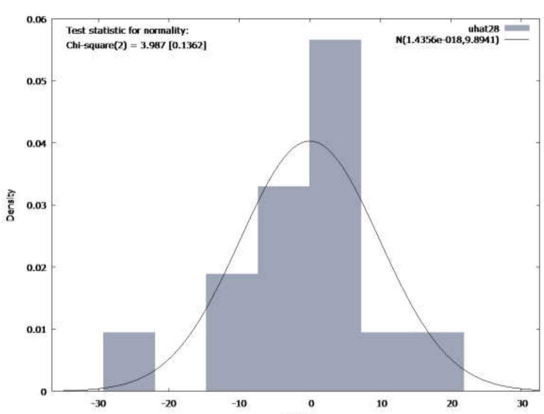


Figure 4.5. Histogram of Residual



The Q-Q plot and histogram in Figure-4.4 and Figure-4.5 show picture of approximate normality for residual. Thus our fitted model ARIMA (0, 1, 0) is an adequate model to forecast rice production in Khyber Pakhtunkhwa.

4.3. Forecast for Rice Production

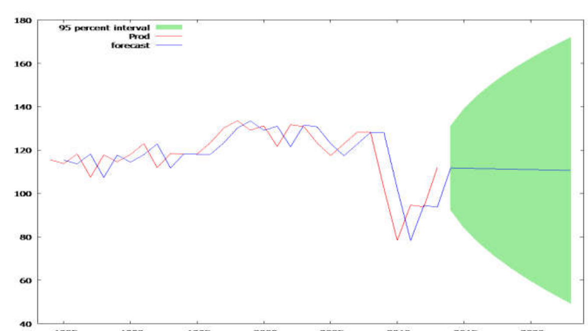
The selected model is used for forecasting the rice production for onward ten years in Khyber Pakhtunkhwa along with their respective predicted values, standard errors, lower and upper confidence limits, based on the sample data are shown in Table-4.3.

Table 4.3. Forecast for Rice Production with effect from 2014-2023

Year	Predicted Production	Std. Error	95% interval
2014	111.8	9.89	92.4 - 131.2
2015	111.7	13.99	84.2 - 139.1
2016	111.5	17.14	77.9 - 145.1
2017	111.4	19.79	72.6 - 150.2
2018	111.3	22.12	67.9 - 154.6
2019	111.2	24.24	63.7 - 158.7
2020	111.0	26.18	59.7 - 162.3
2021	110.9	27.98	56.1 - 165.8
2022	110.8	29.68	52.6 - 169.0
2023	110.7	31.29	49.3 - 172.0

By comparing the original and predicted pear production, it is evident that the original rice production series shows slight increasing tendency with the passage of time i.e. with effect from year 1985-2005. But with the passage of time, it shows decline in rice production with effect from year 2008 to onward. Similarly, predicted period also shows the same declining pattern. In the predicted plot, in sample and out sample forecasting part is shown in Figure-4.6. The forecast for rice production represents generally a downward tendency in the onward time period of ten years.

Figure 4.6. Forecasting Plot for Rice Production



Conclusions and Recommendations

The instant results suggests that the time series modeling for each major food crop production was appropriate and gave best forecast for onward ten years From the results of analyzed data, it can be concluded that for each major food crop i.e. wheat, maize, sugarcane and rice the forecasting models ARIMA (0, 2, 1), ARIMA (1, 2, 3), ARIMA (0,2,1) and ARIMA (0,1,0) respectively were found adequate for forecasting purpose based on forecast evaluation criteria.. Also, it can be recommended that these selected models could be used by researchers, business men, policy makers and food crop producers for information, planning their resources as well as decision making regarding food crops production in Khyber Pakhtunkhwa. Also, at the same time Box-Jenkins ARIMA model give good representation of short time forecasting.

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