The Journal of Animal & Plant Sciences, 24(5): 2014, Page: 1444-1451
ISSN: 1018-7081

TIME SERIES MODELING FOR FORECASTING WHEAT PRODUCTION OF PAKISTAN

M. Amin, M. Amanullah and A. Akbar

Department of Statistics Bahauddin Zakariya University, Multan, Pakistan.
Corresponding Author E mail: ma_amin15@yahoo.com

ABSTRACT

Wheat is the main agriculture crop of Pakistan. For country planning, forecasting is the main tool for predicting the production of wheat to determine the situation what would be the value of production coming year. In this research, we developed time series models and best model is identified for the objective to forecast the wheat production of Pakistan. In this research large time periods i.e. 1902-2005 data was used. Various time series models are fitted on this data using two software's JMP and Statgraphics. We have found that the best model is ARIMA (1, 2, 2). On the basis of this selected model, we have found that wheat production of Pakistan would become 26623.5 thousand tons in 2020 and would become double in 2060 as compared in 2010.

Key words: ARIMA; Time Series models; Wheat Production Forecasting.

INTRODUCTION

Agriculture is the backbone of Pakistan's economy and it contributes to the economic and social well being of the nation through its influence on the gross domestic product (GDP), employment and foreign exchange earnings. In food grain crops, wheat and rice are the most important in the agriculture sector, in that rice contributes 5.4% of value added in agriculture and 1.3% to GDP and wheat accounts for 13.8% in value added in agriculture and 3.4% in GDP (Government of Pakistan, 2004). Agriculture plays an important role in the betterment of the large proportion of the rural population in particular and overall economy in general. Agricultural development is desired in almost every part of the world today. The race between increasing population and food supply is a real grim. Wheat is the main staple food for the people of Pakistan. The unprecedented drought and water shortage conditions have severely affected the wheat crop during the last years.

Wheat production forecasting is mainly depends on the cultivated area. Therefore it is necessary to develop the model for, to determine the estimated wheat production on the basis of cultivated area in the long run. Many studies have been conducted to forecast and determine constraints in the production of major crops such as wheat, cotton and rice in Pakistan. Despite these constraints, there are indeed good prospects for continued growth in the area and yield of wheat and other crops in Pakistan (Hamid *et al.,* 1987; Muhammad, 1989). Qureshi *et al.* (1992) analyzed the relative contribution of area and yield to total production of wheat and maize in Pakistan and concluded that there was more than 100% increase in total wheat production that can be attributed to yield enhancement. Muhammad *et al.* (1992) conducted an empirical study of modeling and forecasting time series data of rice production in Pakistan. ARIMA model has been frequently employed to forecast the future requirements in terms of internal consumption and export to adopt appropriate measures (Muhammad *et al.,* 1992; Shabur and Haque, 1993; Sohail *et al.*, 1994).

Factually, other crops in general and wheat in particular provide linkages through which it can stimulate economic growth in other sectors. Wheat cultivation has been suffering from various problems, such as traditional methods of farming, low yields, shortage of key inputs and shortage of irrigation water. Pakistan has experienced ups and downs in wheat production. Prices of wheat and flour boosts up during low production seasons and falls drastically when there is a surplus wheat production, however, surplus wheat production occurred for few years and during such periods farming community suffered heavy losses due to inadequate marketing facilities in the country. On the other hand, farmers do not know future prospect of wheat production and prices while deciding to cultivate this and other crops. There is a dire need to forecast area, yield and production of wheat in Pakistan. Therefore, the objective of this paper is to determine future prospects of wheat in the country using past trends.

Karim *et al.* (2005) applied regression modeling to forecast wheat production of Bangladesh districts. They used seven model selection criteria's and found that different models were identified for different districts for wheat production forecasts. They have found that wheat production in Bangladesh districts i.e. Dinajpur, Rajshahi, and Rangpur would be 1.54, 0.35, 0.31, and 0.58 million tons, respectively, in 2009/10. Iqbal *et al.* (2000) used

ARIMA model for forecasting wheat area and production in Pakistan. They used ARIMA (1,1,1) model for wheat area forecasting and ARIMA(2,1,2) model for wheat production forecasting. They have found that for 2000-2001 forecasts of wheat area was about 8451.5 thousand hectares. A wheat area forecast for the year 2022 was 8475.1 thousands hectares. Forecasts of wheat production showed an increasing trend. For 2000-2001, a forecast of wheat production was about 20670.8 thousands tons while wheat production forecast for the year 2022 came to be about 29774.8 thousand tons. Boken (2000), in Canadian Prairies were applied different time series models on wheat yield to forecast spring wheat yield. He used MSE as deterministic criteria to select the best model and found that quadratic model is best for wheat yield forecasting. While on the basis of stochastic criteria, he found that simple average model is best. Saeed *et al.* (2000) has also applied time series model to forecasts wheat production of Pakistan. They used the wheat production data series from 1947-48 to 1998-99 but they have not mentioned the source of data. They suggested ARIMA (2,2,1) model for wheat forecast of Pakistan, on the basis of this model they further forecast wheat production for 15 years i.e. 1999-2000 to 2012-2013. For 2012-2013, they predicted that forested wheat production is 26048.3 million tons. Schmitz and Watts (1970) were applied time series modeling to predict wheat yield of four countries Canada, United States, Australia and Argentina for the period 1950 to 1966. They compare parametric time series modeling and smoothing and conclude that trend models are best for yield forecasting. Sabir and Tahir (2012) forecast the wheat production, area, and population for the year 2011-12 by using exponential smoothing. They have found that the need of wheat is 12.70 million tons for the population of 97.67 million for the year 2011-12.

All they studied and forecast the wheat production on the basis of small time periods data and not given any discussion about the assumptions of selected time series model. The objective of the current study is to forecast the wheat production of Pakistan on the basis of large data and time series model with certain model assumptions are hold for better planning to improve the production to fulfill the demand of Pakistan nation.

MATERIALS AND METHODS

Respective time series data for this study were collected from Government Publications such as Agricultural Statistics of Pakistan and Pakistan Economic Survey. For forecasting purposes, various models are available and we are seeking for the best one. Box and Jenkins (1976) linear time series model are applied in our research for forecasting wheat production to meet the challenges i.e. shortage of wheat in advanced. Autoregressive Integrated Moving Average (ARIMA) is the most general class of models for forecasting a time series. Different series appearing in the forecasting equations are called “Autoregressive” process. Appearance of lags of the forecast errors in the model is called “moving average” process. The ARIMA model is denoted by ARIMA (p,d,q), where “p” stands for the order of the auto regressive process, ‘d’ is the order of differencing and ‘q’ is the order of the moving average process. Some of our study interest ARIMA models with reference are given in table 1;

Table 1. Forms of time Series models for wheat production of Pakistan

Sr. No	Models Name	Model Equation	Reference
1	Random Walk With Drift	$y_t = y_{t-1} + \bar{}_0 + e_t$	Casella, *et al*., 2008
3	Linear Trend	$y_t = a + bt + e_t$	Casella, *et al*., 2008
4	Simple Exponential Smoothing	$\hat{y}_t = \sim y_t + (1 - \sim)\, y_{t-1}$	Casella, *et al*., 2008
5	ARIMA (0, 1, 1) = IAM (1, 1) with constant	$y_t = y_{t-1} + \bar{}_0 + e_t + \bar{}\, e_{t-1}$	Casella, *et al*., 2008
6	ARIMA (0, 1, 1) = IAM (1, 1)	$y_t = y_{t-1} + e_t + \bar{}\, e_{t-1}$	Casella, *et al*., 2008
7	ARIMA (0, 1, 2) with constant	$y_t = y_{t-1} + \bar{}_0 + e_t - \bar{}_1 e_{t-1} - \bar{}_2 e_{t-2}$	Casella, *et al*., 2008
8	ARIMA (1, 1, 1) with constant	$y_t = (1 + \text{¤})\, y_{t-1} + \text{¤}\, y_{t-2} + \bar{}_0 + e_t - \bar{}_1 e_{t-1}$	Casella, *et al*., 2008
9	ARIMA (1, 1, 1)	$y_t = (1 + \text{¤})\, y_{t-1} + \text{¤}\, y_{t-2} + e_t - \bar{}_1 e_{t-1}$	Casella, *et al*., 2008
10	ARIMA (0, 2, 2) with constant	$y_t = 2y_{t-1} - y_{t-1} + \bar{}_0 + e_t - \bar{}_1 e_{t-1} - \bar{}_2 e_{t-2}$	Casella, *et al*., 2008
11	ARIMA (0, 2, 2)	$y_t = 2y_{t-1} - y_{t-2} + e_t - \bar{}_1 e_{t-1} - \bar{}_2 e_{t-2}$	Casella, *et al*., 2008

For more forms of time series models and parameter estimation in detail see (Casella *et al.,* 2008; Tsay, 2005; Chatfield, 1995). In ARIMA modeling, the order of AR(p) is identified by partial autocorrelation function (PACF) while the order of MA(q) is identified by autocorrelation function (ACF) (Tsay, 2002). The order of ARIMA (p, d, q) is also identified by model selection criteria's i.e. Schwarz Bayesian information criteria (SBIC) and Akaike's Information Criteria (AIC) (Casella, *et al.*, 2008). These criteria's are further explained in model specification section.

Model Specification: One of the important issues in time series forecasting is to specify model. Time series model is specified on the basis of some information criteria's which includes AIC, BIC likelihood etc. Akaike's (1973) introduced AIC criteria for model specification. AIC is mathematically defined as;

$$AIC = -2\log\left(\max imum\, likelihood\right) + 2k$$

Where k = p+q+1 (if model includes intercept) otherwise k = *p*+*q*. model specified well if its AIC value is minimum as other fitted models (Tsay, 2005). Other model specification criterion is SBIC and is computed as;

$$SBIC = -2\log\left(\max imum\, likelihood\right) + 2k\log\left(n\right)$$

.

Model which has minimum SBIC value specified well as other fitted models (Tsay, 2005)

Time Series Model Diagnostics: The time series model assumption includes independence, normality, autocorrelation etc of residuals of the best fitted models. Autocorelation is tested by Runs Test (Gujarati, 2004) and Box- Pierce test developed by Box and Pierce (1970) and ACF and PACF are also used to detect the autocorrelation in the data (Elivli *et al.,* 2009). Residual normality is tested through normal probability plot, and residual integrated periodogram which displays Kolmogorov-Smirnov 95 % and 99 % bounds. If the residuals are random then periodogram fall within these bounds, which is also an indication of white noise of residuals (Casella *et al.*, 2008).

Forecasting Accuracy Measuring Techniques: After model selection, a next important step is to measure the accuracy to verify the reliability of forecasted value based selected model. Various tools are available in literature which includes Root mean square error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), mean error (ME) and mean percentage error (MPE). Further computation and literature of these accuracy measuring tools are given in table 2;

Table 2. Forecasts accuracy measuring tools

Accuracy measuring tool	Formulation	Reference
MAE	$MAE = \frac{\sum_{t=1}^{n}\lvert e_t\rvert}{n}$	Makridakis *et al.,* 2003
ME	$ME = \frac{\sum_{t=1}^{n} e_t}{n}$	Makridakis *et al.,* 2003
MSE	$MSE = \frac{1}{n}\sum_{t=1}^{n} e_t^2$	Makridakis *et al.,* 2003
MPE	$MPE = \frac{1}{n}\sum_{t=1}^{n} PE_t$	Makridakis *et al.,* 2003
MAPE	$MPE = \frac{1}{n}\sum_{t=1}^{n}\lvert PE_t\rvert$	Makridakis *et al.,* 2003

Where $PE_t = \left(\frac{Y_t - F_t}{Y_t}\right)\times 100$ and F_t is the forecasted value for time *t.*

RESULTS AND DISCUSSION

In this research, time series models were fitted on wheat production data of Pakistan. The objective of fitting multiple time series models on this data is to obtained reliable forecasts on the basis of statistical measures.

Wheat production Forecasting 1902-2005

In table 4, different time series models fitted and results are presented with model selection and validity criteria's. On the basis of AIC we have found that Model M i.e. ARIMA(1, 2, 2) has lowest AIC and we use this model to forecast wheat production of Pakistan on the basis of historical data i.e. 1902-2005. In this table we also summarize the results of five tests run on the residuals to determine whether each model is adequate for the data. Note that the currently selected model, model M, passes 4 tests. Since no tests are statistically significant at the 95% or higher confidence level, the current model is probably adequate for the data. Similar results are also obtained by using JMP Software as on the basis of AIC and SBC ranks the best selected model is ARIMA (1, 2, 2) and the results are shown in table 3. The ARIMA(1,2,2) model coefficient summary is given in table 5.

Table 3. Model Comparison Using JMP8 of Wheat Production Forecasting 1902-2005 of Pakistan

Model Comparison

Model	DF	Variance	AIC	SBC	RSquare	-2LogLH	AIC Rank	SBC Rank	MAPE	MAE
AR(1)	102	771122.43	1711.6195	1716.9083	0.945	1707.6195	10	5	18.885286	715.53708
MA(1)	102	9371063.9	1969.1135	1974.4023	0.695	1965.1135	13	13	53.699273	2502.5222
ARI(1, 1)	101	644945.13	1672.2369	1677.5064	0.979	1668.2369	7	5	12.703146	595.97561
IMA(1, 1)	101	626092.23	1669.2272	1674.4967	0.980	1665.2272	5	4	12.644369	584.07065
ARMA(1, 1)	101	4544024.7	1898.8276	1906.7608	0.844	1892.8276	12	12	44.779053	1810.4513
ARIMA(1, 1, 1)	100	631450.89	1671.0903	1678.9945	0.980	1665.0903	6	6	12.622210	583.76824
ARMA(1, 2)	100	716022.72	1706.0878	1716.6654	0.950	1698.0878	9	8	18.071055	688.17733
ARMA(2, 1)	100	776398.49	1729.1383	1739.7168	0.968	1721.1383	11	11	16.364235	691.36946
ARIMA(2, 1, 2)	98	606043.28	1669.1237	1682.2974	0.981	1659.1237	4	7	12.392689	569.83827
ARMA(2, 2)	99	704568.64	1705.5426	1718.7646	0.950	1695.5426	8	10	18.379720	688.70084
ARIMA(1, 2, 2)	98	507877.76	1640.1094	1650.6093	0.983	1632.1094	1	1	12.248621	573.87431
ARIMA(2, 2, 2)	97	513509.74	1642.0569	1655.1817	0.983	1632.0569	2	2	12.246647	573.69658
ARIMA(2, 2, 1)	98	559269.67	1649.4734	1659.9733	0.982	1641.4734	3	3	12.164777	558.30944

Model Comparison Using Statgraphics 15

Models

(A) Random walk with drift = 196.165
(B) Constant mean = 6761.69
(C) Linear trend = -305605. + 159.901 t
(H) Simple exponential smoothing with alpha = 0.7077
(I) Brown's linear exp. smoothing with alpha = 0.197
(J) Holt's linear exp. smoothing with alpha = 0.1112 and beta = 0.6644
(M) ARIMA(1,2,2)
(N) ARIMA(0,2,2)
(O) ARIMA(1,1,2)
(P) ARIMA(0,2,2) with constant
(Q) ARIMA(1,0,1) with constant

Table 4. Model Selection and validity model testing criteria's of Wheat production Forecasting based on 1902-2005

Model	*eRMSE*	*MAE*	*MAPE*	*ME*	*MPE*	*AIC*	*RMSE*	*RUNS*	*RUNM*	*AUTO*	*MEAN*	*VAR*
(A)	851.908	618.639	13.0096	8.83005E-14	-3.73582	13.5142	851.908	OK	OK	OK	OK	**
(B)	5577.81	4637.86	97.1633	-3.53304E-12	-67.0982	17.2723	5577.81	*	***	***	***	***
(C)	2814.55	2365.87	53.832	-2.96635E-11	-5.30844	15.9236	2814.55	*	***	***	OK	**
(H)	833.578	605.206	11.8379	262.469	1.70305	13.4707	833.578	OK	OK	OK	**	***
(I)	733.613	541.758	11.1163	118.53	0.52926	13.2152	733.613	*	OK	OK	OK	**
(J)	717.878	543.487	11.6289	31.8212	-1.23138	13.1911	717.878	OK	OK	OK	OK	***
(M)	705.377	538.004	10.7913	43.3898	-0.236575	13.1752	705.377	OK	OK	OK	OK	***
(N)	721.774	538.285	10.8728	53.2794	-0.481246	13.2019	721.774	OK	OK	OK	OK	***
(O)	728.637	535.153	10.8385	75.1509	-0.0492618	13.24	728.637	OK	OK	OK	OK	***
(P)	735.449	540.974	11.0765	-2.79145	-2.77791	13.2587	735.449	OK	OK	OK	OK	**
(Q)	740.586	538.79	10.9465	41.5256	-1.43001	13.2726	740.586	OK	OK	OK	OK	**

Table 5. ARIMA (1,2,2) Model Coefficient Summary

Parameter	Estimate	Stnd. Error	t	P-value
AR(1)	0.209104	0.0995956	2.09954	0.038313
MA(1)	1.85085	0.0314206	58.9058	0.000000
MA(2)	-0.928474	0.0350945	-26.4564	0.000000

On the basis of Table 5, model coefficients the estimated wheat forecasted model is;

$$\hat{y}_t = 0.209104\hat{y}_{t-1} + 1.85085\hat{e}_{t-1} - 0.928472\hat{e}_{t-2}$$

Where $\hat{y}_t$ is the forecasted wheat production for time *t* years.

$\hat{y}_{t-1}$ is the forecasted wheat production of one previous year

$\hat{e}_{t-1}$ is the previous one year residual as indicated in appendix table

$\hat{e}_{t-2}$ is the previous two year residual as indicated in appendix table

Testing Selected Model Assumptions (Normality, Autocorrelation and Heteroscedasticity): We get the reliable wheat production future value if the selected model is good. Selected model is good one, if it fulfills the assumptions i.e. Normality, Autocorrelation and Heteroscedasticity of the selected model residuals.

Table 6. Tests for Autocorrelation and Independence

Test	Test Statistic Value	p-value
Runs above and below median	0.4975	0.6188
Runs up and down	-0.0394	1.0000
Box-Pierce Test	15.3043	0.8074

Table 6, indicated that the ARIMA (1, 2, 2) model residuals are uncorrelated as well as independent as all three tests signify.

Three tests have been run to determine whether or not the residuals form a random sequence of numbers. A sequence of random numbers is often called white noise, since it contains equal contributions at many frequencies. The first test counts the number of times the sequence was above or below the median. The number of such runs equals 49, as compared to an expected value of 52 if the sequence were random. Since the P-value for this test is greater than or equal to 0.05, we cannot reject the hypothesis that the residuals are random at the 95.0% or higher confidence level. The second test counts the number of times the sequence rose or fell. The number of such runs equals 68, as compared to an expected value of 67.67 if the sequence were random. Since the P-value for this test is greater than or equal to 0.05, we cannot reject the hypothesis that the series is random at the 95.0% or higher confidence level. The third test is based on the sum of squares of the first 24 autocorrelation coefficients. Since the P-value for this test is greater than or equal to 0.05, we cannot reject the hypothesis that the series is random at the 95.0% or higher confidence level. The normality is also tested by normal probability plot as shown in figure (1) and periodogram as shown in figure (4) both figures indicated that the residuals of ARIMA (1, 2, 2) are normally distributed. The heteroscedasticity is tested by Var test as show in Table 3 indicated that ARIMA (1, 2, 2) residuals are heteroscedastic. There is no indication of autocoorelation in residuals of selected model signifies by runs and Box-Pierce test.

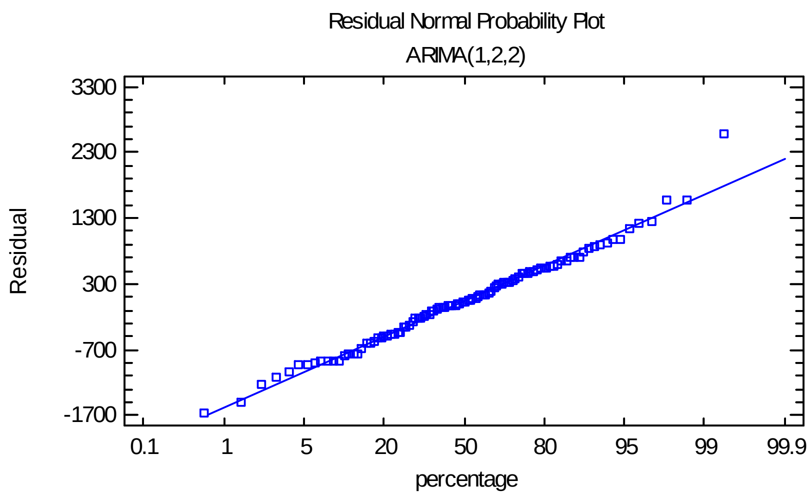

Figure 1. Residuals Normal Probability Plot of Wheat Production Model for 1902-2005

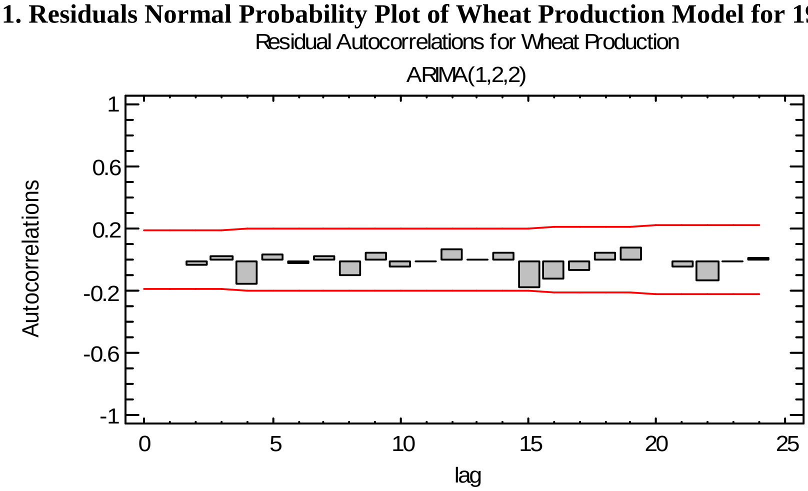

Figure 2. Residuals Autocorrelation Plot of Wheat Production of ARIMA (1, 2, 2) Model

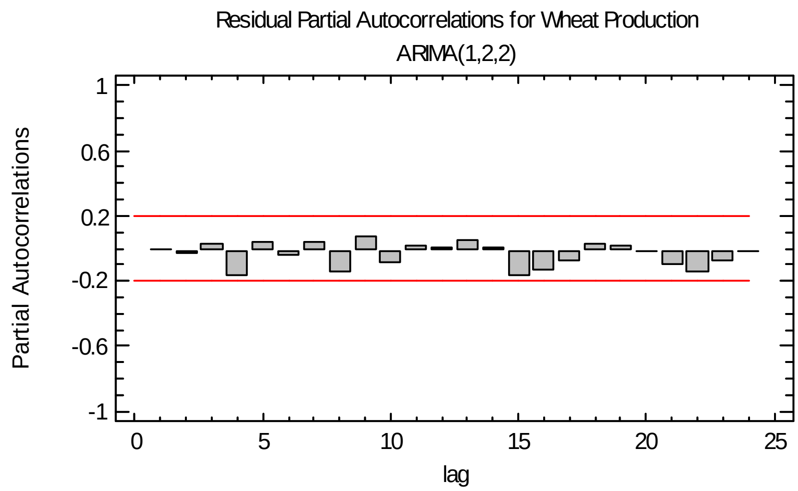

Figure 3. Residuals Partial Autocorrelation Plot of Wheat Production of ARIMA (1, 2, 2)

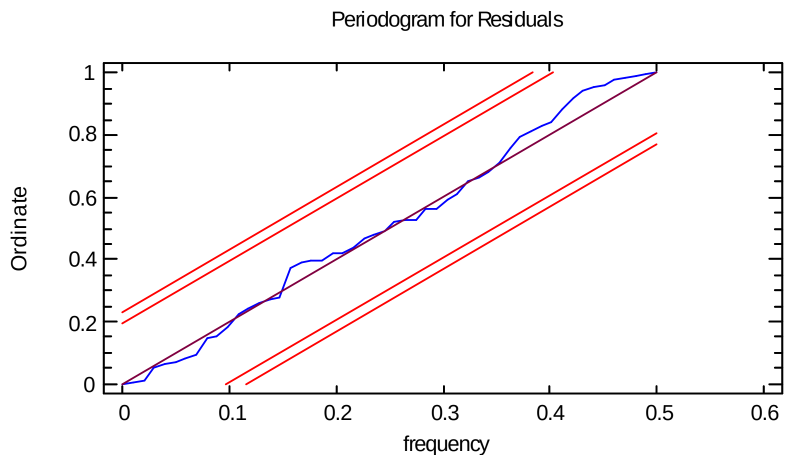

Figure 4. Periodogram of Residuals for Wheat Production ARIMA (1, 2, 2) Model

Table 7. One step ahead forecasts and residuals for wheat production data (1902-2005)

year	Data	Forecast	Residual
2006	21277	21440.7	-164
2007	23295	21705.9	1589
2008	20959	22062.4	-1104
2009	24033	22438	1595
2010	23311	22817.6	493

Table 8. Wheat production forecasts (in thousand tons) with interval of 10 years

Year	2020	2030	2040	2050	2060
Forecast	26623.5	30429.8	34236	38042.2	41848.5

One step ahead forecasts and residual of wheat production on the basis of 1902 to 2005 wheat production data for the year 2006 to 2010 is presented in table 7. Wheat production forecasted value on the basis of ARIMA (1,2,2) model with interval of 10 year from 2020 to 2060 is presented in table 8 . From table 6, we have found that wheat production of Pakistan would become 26623.5 thousand tons in 2020, 30429.8 in 2030, 34236 in 2040, 38042.2 in 2050 and 41848.5 thousand tons in 2060. As the forecasting is based on sound statistical formulation, so it is adequate forecasting provided that the environmental conditions remain same.

Conclusion: As the population increases over time gradually, therefore it is necessary to plan to meet the requirements of nation. For this purpose, forecasting is the key tool to alarm about the need of nation in advance. Wheat is the basic need of any country all over the world. In this study, we developed time series models to forecasts wheat production of Pakistan on the basis of historical data i.e. 1902-2005. We have developed different time series models on wheat production of Pakistan on this data. Best model is selected on the basis of model selection criteria i.e. AIC and SBIC. Main interest of developing time series model as other studies is that the model fitted is also satisfied residual assumptions i.e. normality, independence and no autocorrelation. On the basis of these model selection criteria, we have found that best model for wheat production forecasting of Pakistan is ARIMA (1, 2, 2). On the basis of developed time series model, we have found that best time series model for forecasting wheat production of Pakistan is ARIMA (1, 2, 2) because this model has lower AIC and SBIC as compared to other fitted time series models. On the basis of this model, we have found that wheat production of Pakistan would become 26623.5 thousand tons in 2020 and would become double in 2060 as compared in 2010 under the assumption that there is no irregular movement or variation is occurred.

REFERENCES

Boken, V.K. (2000). Forecasting spring wheat yield using time series analysis: a case study for the Canadian Prairies. Agron. J, 92:1047-1053.

Box, G.E.P. and G.M. Jenkin (1970). Time Series Analysis, Forecasting and Control. (San Francisco: Holden-Day,).

Box, G.E.P. and D.A. Pierce (1970). Distribution of residual autocorrelations in autoregressive-integrated moving average time-series models. J. Amer. Stat. Asso. 65:1509-26.

Box, G.E.P., G.M. Jenkins and G.C. Reinsel (1994). Time series Analysis, Forecasting and Control. 3rd Ed. Englewood Cliffs, N J: Prentice-Hall.

Chatfield, C. (1995). The Analysis of Time Series an Introduction. 5th Ed. Chapman & Halljcrc Boca Raton London New York Washington, D.C.

Elivli, S., N. Uzgoren and M. Savas (2009). Control charts for autocorrelated colemanite data. J.Sci. Indust Res. 68: 11-17.

Government of Pakistan. (2004). Economic Survey 2003–2004 Finance Division. Economic Adviser's Wing, Islamabad.

Hamid, N.P., V. Thomas, Alberto and G. Suzanne (1987). The wheat economy of Pakistan setting and prospects. International Food Policy Research Institute, Ministry of Food and Agriculture, Government of Pakistan, Islamabad, Pakistan.

Iqbal, N., K. Bakhsh, K. Maqbool, and A.S. Ahmad (2000). Use of the ARIMA model for forecasting wheat area and production in Pakistan. Int. J. Agri. Biol. 2: 352-354.

Karim, R., A. Awal and M. Akhter (2005). Forecasting of wheat production in Bangladesh. J.Agri. Soc. Sci. 1: 120–122.

Makridakis, S., S.C. Wheelwright and R.J. Hyndman (2003). Forecasting: methods and applications. 3rd Ed. John Wiley and Sons.

Muhammad, K. (1989). Description of the historical background of wheat improvement in baluchistan, Pakistan. Agriculture Research Institute (Sariab, Quetta, Baluchistan, Pakistan).

Muhammad, F., M. Siddique, M. Bashir and S. Ahmad (1992). Forecasting rice production in Pakistan using ARIMA Models. J.Anim.Plant.Sci. 2: 27–31.

Sabir, H.M. and S.H. Tahir, (2012). Supply and demand projection of wheat in Punjab for the year 2011-2012. Interdis. J. Contemp. Res. Bus. 3: 800-808.

Saeed, N., A. Saeed, M. Zakria and T.M. Bajwa (2003). Forecasting of wheat production in Pakistan using arima models. Int. J. Agri. Biol. 2:352-353.

Tsay, R.S. (2002). Analysis of Financial Time Series: Financial Econometrics. John Wiley & Sons, Inc.

Qureshi, K., A.B. Akhtar, M. Aslam, A. Ullah andA. Hussain (1992). An Analysis of the relative contribution of area and yield to Total production of wheat and maize in Pakistan. J. Agri. Sci. 29: 166–169.

Shabur, S.A. and M.E. Haque (1993). An analysis of rice price in Mymensing town market pattern and forecasting. Bang. J. Agri. Econo. 16: 61-75.

Sohail, A., A. Sarwar and M. Kamran (1994). Forecasting total food grains in Pakistan. J. Engi. Appl. Sci. 13: 140- 146.

Appendix

ARIMA (1, 2, 2) 1902-2005			
Period(t)	*Wheat Production* (y_t)	*Forecasted value of wheat production* $(\hat{y}_t)$	*Residual* $(\hat{e}_t)$
1902	1407		
1903	1931		
1904	2795	2244.67	550.329
1905	2491	2464.92	26.0801
1906	3972	2405.46	1566.54
1907	2520	2951.03	-431.034
1908	2099	2706.97	-607.967
1909	2770	2618.64	151.36
1910	2916	2824.72	91.2836
1911	2913	2923.8	-10.8009
1912	2801	2983.59	-182.589
1913	2475	2994.12	-519.124
1914	2670	2895.55	-225.545
1915	3230	2909.4	320.599
1916	2185	3063.53	-878.53
1917	2557	2728.08	-171.084
1918	3174	2726.26	447.74
1919	2372	2854.68	-482.683
1920	3034	2582.37	451.629
1921	1793	2718.07	-925.072
1922	3251	2285.57	965.429
1923	2887	2627.6	259.398
1924	2864	2558.28	305.721
1925	2248	2587.3	-339.304
1926	2545	2419.86	125.143
1927	2598	2486.26	111.744
1928	1737	2509.35	-772.349
1929	2781	2218.13	562.865
1930	3329	2464.46	864.543
1931	2731	2695.75	35.2521
1932	2599	2630.83	-31.8252
1933	2639	2656.08	-17.077
1934	2782	2717.02	64.9758
1935	2866	2810.42	55.5784
1936	2962	2895.12	66.8763
1937	3184	2988.33	195.666
1938	3080	3132.29	-52.2913
1939	3146	3186.29	-40.2861
1940	3594	3273.56	320.44
1941	3137	3491.39	-354.387
1942	3743	3444.2	298.802
1943	4168	3689.2	478.8
1944	3495	3946.39	-451.394
1945	3824	3872.42	-48.4207
1946	3506	4033.03	-527.035
1947	3115	3983.22	-868.215
1948	3354	3826.34	-472.337
1949	4038	3792.85	245.154
1950	3924	3922.76	1.24372
1951	3993	3868.45	124.549
1952	3010	3870.9	-860.899
1953	2405	3516.06	-1111.06
1954	3645	3136.13	508.872
1955	3186	3297.36	-111.361
1956	3370	3050.32	319.681
1957	3639	2993.37	645.625
1958	3564	3027.63	536.367
1959	3907	3023.78	883.223
1960	3909	3200.69	708.308
1961	3814	3348.77	465.228
1962	4027	3495.29	531.707
1963	4170	3752.24	417.756
1964	4162	4018.83	143.165
1965	4591	4245.32	345.678
1966	3916	4604.51	-688.505
1967	4335	4605.42	-270.423
1968	6419	4844.02	1574.98
1969	6618	5685.01	932.987
1970	7295	6158.35	1136.65
1971	6476	6834.43	-358.43
1972	6890	7062.93	-172.933
1973	7442	7549.11	-107.106
1974	7629	8060.53	-431.53
1975	7674	8438.93	-764.93
1976	8621	8704.42	-83.4166
1977	9144	9200.79	-56.7865
1978	8367	9605.99	-1238.99
1979	9950	9558.63	391.367
1980	10857	10151.8	705.248
1981	11475	10680.7	794.291
1982	11915	11217.3	697.743
1983	12414	11763.8	650.162
1984	10882	12369.8	-1487.82
1985	11703	12282.7	-579.701
1986	13923	12707.6	1215.44
1987	12882	13647.7	-765.706
1988	12675	13704.8	-1029.82
1989	14419	13837.5	581.499
1990	14316	14538.5	-222.533
1991	14565	14778.6	-213.566
1992	15684	15076.3	607.732
1993	16157	15661.8	495.192
1994	15213	16142.7	-929.655
1995	17002	16153.1	848.875
1996	16907	16928.2	-21.1805
1997	16651	17245.4	-594.407
1998	18694	17441.8	1252.17
1999	17858	18348.3	-490.255
2000	21079	18490	2589.01
2001	19024	19901.3	-877.264
2002	18226	19893.3	-1667.28
2003	19183	19962.2	-779.223
2004	19500	20401.2	-901.177
2005	21612	20627.6	984.369