Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6613

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (4):** 468-476 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Forecasting the Prices of Greengram in Selected Markets of Andhra Pradesh

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Received: 15.06.2018 | Revised: 22.07.2018 | Accepted: 4.08.2018

ABSTRACT

Pulses are an important commodity group of crops that provide high quality protein complementing cereal proteins for pre-dominantly substantial vegetarian population of the country. Although, being the largest pulse crop cultivating country in the World, pulses share to total foodgrain production is only 6-7% in the country. The main purpose of this paper is to identify the Auto-Regressive Integrated Moving Average (ARIMA) model by Box Jenkin's method that could be used to forecast the prices of greengram in Suryapeta and Thandur markets. The secondary data pertaining to monthly prices (Rs/Qtls) of greengram collected from April 2000 to December 2014 has been used for the study. The best selected ARIMA model for forecasting the greengram prices in Suryapeta was ARIMA (0,1,1), and, for Thandur market it was ARIMA (1,0,1). This paper makes a comparison between the original and forecasted prices which was relatively closer to the real values in both Suryapeta and Thandur markets.

Key words: *Greengram prices, ARIMA, AIC, PACF, Forecasting*

INTRODUCTION

In India, pulses can be produced with a minimum use of resources and hence, it becomes less costly even than animal protein. In comparison to other vegetables, pulses are rich in protein which are less expensive and can be cultivated as an inter-crop and also as mixed crop. Pulses are mostly cultivated under rainfed conditions and do not require intensive irrigation facility and this is the reason why pulses are grown in areas left after satisfying the demand for cereals/cash crops. Even in such conditions, pulses give better returns. Apart from this, pulses possess several other qualities such as they are rich in protein, improve soil fertility and physical structure, fit in mixed/inter-cropping system, crop rotations and dry farming and provide green pods for vegetable and nutritious fodder for cattle as well. Green gram is one of the main pulses crop in India and believed to be originated from India. It is short duration legume crop grown mostly as a fallow crop in rotation with rice. Similar to the leguminous pulses, green gram, enriches soil nitrogen content.

Cite this article: Divya, K., Rajeswari, S., Bhavani Devi, I. and Sumathi, P., Forecasting the Prices of Greengram in Selected Markets of Andhra Pradesh, *Int. J. Pure App. Biosci.* **6(4):** 468-476 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6613

It is grown mostly in Asian region traditionally while its cultivation has spread to Africa and Americas relatively in the recent times. More than 70% of world's green gram production comes from India. It was cultivated over an area of 3.38 million hectares with a production of 1.61 million tonnes and productivity of 474 kgs. per hectare in 2013-14. In Andhra Pradesh, Greengram is one of the most widely grown pulse crops. It was cultivated over an area of 33.3 lakh hectares with a production of 15.3 lakh tonnes and productivity of 461 kgs. per hectare in 2013-14.

Green gram is cultivated in Andhra Pradesh in all seasons i.e. kharif, rabi, rice fallows and summer. It is grown as a sole, inter-mixed and catch crop. Local varieties are late maturing and low yielders. As a result of intensive research PDP 71-1 LGG-127 (kondaveedu) LGG-122 which are shorter in duration with high yield potential (10 q/ha) were released from the state. As a result of intensive testing under AICPIP, HB16, PIMS, and PIMS, were found to be better yielders for Andhra Pradesh in kharif and rice-fallows. Price prediction is highly useful for forecasting the market price for the pulses. It is also useful for farmers to plan their crop cultivation activities so that they could fetch more price in the market. Government can use the market forecast price for planning imports and managing domestic markets to stabilize the market price for the pulses. Consumers can use this price prediction for their consumption planning. Forecasting of prices of farm commodities is a risky venture because price forecasts may go away due to weather factors, economic factors or some unforeseen factors and consequently they may render forecasts invalid. Therefore, some flexibility is allowed in the fluctuations of forecast price to the extent of 5-10 percent depending upon the crop. This paper applied forecasting models to analyze farm produce price so that market players can be guided according to market changes, and therefore farmers, peasant brokers, enterprises as well as government can make decisions in relation to price forecast and market adjustment in a more rational way.

MATERIAL AND METHODS

The ARIMA model of price forecasting was used to forecast the prices of greengram. Two markets were selected based on its on the average arrivals of the three years i.e., 2011 to 2014. The two markets selected for greengram are Suryapeta and Thandur. The monthly modal prices for 14 years from the selected markets of greengram were collected to predict the selected pulse crop for the months commencing from January 2015 to March 2015.

Box-Jenkins models

ARIMA forecasting model is applied for large stationary data and involved four different but interrelated steps.

Step-I: Identification

The first step of applying Box-Jenkins forecasting model is to identify the appropriate order of ARIMA (p, d, q) model. Identification of ARIMA model implies selection of order of AR (p), MA (q) and I (d). The order of d is estimated through I (1) or I (0) process of unit root stationary tests. The model specification and selection of order p and q involved plotting of autocorrelations (ACF) and partial autocorrelations functions (PACF) or correlogram of variables at different lag length. The autocorrelation functions specify the order of moving average process, q and partial autocorrelations select autoregressive of order p. The ACF shows autocorrelation coefficients at different lag length with 95% confidence interval whether they are statistically significantly different from zero or not.

$$Y_t = \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots\ldots\ldots + \Phi_p Y_{t-p} + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \ldots\ldots\ldots - \theta_q e_{t-q}$$

Where, Y_t is the original series, for every t, we assume that is independent of Y_{t-1}, Y_{t-2} , Y_{t-3}, …, Y_{t-p} . A time series $\{Y_t\}$ is said to follow an integrated autoregressive moving average (ARIMA) model if the d^{th} difference $W_t = \nabla dYt$ is a stationary ARMA process. If $\{W_t\}$ follows an ARMA (p,q) model, we say that $\{Y_t\}$ is an ARIMA(p,d,q) process. Fortunately, for practical purposes, we can usually take d = 1 or at most 2.

Step-II: Estimation of the model

Once the order of p, d, and q are identified, next step is to specify appropriate regression model and estimate it. With the help of SPSS software various order of ARIMA model has been estimated to arrive at the optimal model. For example, if a series is identified as ARIMA (2, 1, 1) it means the series is stationary at first difference and follows AR (2) and MA (1) process. The regression model is estimated with simple ordinary least squares methods. Once the model is estimated, significance of each coefficient are tested. The adjusted R^2 provides whether the model is a good model or not as does in case of multiple linear regression models.

Step-III: Diagnostic checking

One simple way to answer is diagnostic checking on residual term obtained from ARIMA model applying the same ACF and PACF functions. Obtain ACF and PACF of residual term up to certain lags of the estimated ARIMA model and then check whether the coefficients are statistically significant or not with Box-Pierce Q and Ljung- Box LB statistics, respectively. If the result obtains from the model is purely random, then estimated ARIMA model is correct or else we have to look for alternative specification of the model. Similarly, diagnostic checking can also be done through Adjusted R2, minimum of Akaike Information Criteria (AIC) and Schwarz Bayesian Criteria (SBC).

Step-IV: Forecasting

Once the three previous steps of ARIMA model is over, then we can obtained forecasted values by estimating appropriate model, which are free from problems.

RESULTS AND DISCUSSION

Forecasting prices of greengram in Suryapeta and Thandur markets

The tentative models were first identified based on the autocorrelation function (ACF) and partial autocorrelation function (PACF) for the given set of time series data. The forecasts were tested with AIC and SBC values to assess the accuracy of the model. Finally the Box-Jenkins methodology used to estimate the ARIMA showed that the model (0, 1, 1) in Suryapeta market and the model (1, 0, 1) was found as the best model in Thandur market.

Table 1: AIC and SBC analysis of monthly prices of greengram in selected markets

Market	Model	AIC	SBC
Suryapeta	011	2661.7746	2668.1155
Thandur	101	2685.684	2695.2124

Table 2: ACF and PACF values of monthly prices of greengram in Suryapeta and Thandur markets

ACF and PACF of monthly prices of greengram in Suryapeta market (011)		
Lags	**ACF**	**PACF**
1	.015	.015
2	-.086	-.086
3	.084	.087
4	-.130	-.143
5	-.058	-.036
6	-.004	-.035
7	-.003	.013
8	-.037	-.053
9	.102	.101
10	-.026	-.053

11	-.043	-.013
12	-.054	-.094
13	-.106	-.080
14	-.110	-.128
15	.099	.104
16	.118	.082

ACF and PACF of monthly prices of greengram in Thandur market (101)

Lags	ACF	PACF
1	-.017	-.017
2	.038	.038
3	-.029	-.028
4	.063	.061
5	-.008	-.004
6	-.010	-.016
7	.029	.033
8	.051	.049
9	-.125	-.127
10	.096	.095
11	-.093	-.086
12	-.002	-.023
13	-.016	.013
14	.006	-.012
15	-.021	-.019
16	.065	.081

Both ex-ante and ex-post forecasting were done and it was compared with actual observations. The prices were forecasted up to March, 2015. The results of ex-ante and ex-post forecasted prices of Suryapeta and Thandur markets are presented in Table 3 and 4 and illustrated in Fig. 1 and 2. As it can be seen from the graph that the actual and forecasted prices of greengram in the selected markets were more or less closer in Suryapeta market Where as in case of there was much variation between actual and forecasted prices in Thandur market. According to the forecasts the price of greengram in Suryapeta market would be ranging from Rs.6137 to Rs.6187 per quintal and in Thandur market would be ranging from Rs.6277 to Rs.6813 per quintal for the months from January to March 2015. Chaudari and Tingre[3] also estimated greengram prices for Maharashtra would increasing from Rs.4646 per quintal during October 2012 to Rs.4729 per quintal during February 2013.

Table 3: Ex-ante and ex-post forecast of greengram prices in Suryapeta market

Year	Month	Actual price	Predicted price	Year	Month	Actual price	Predicted price
2000	Apr	1800	-	2004	Jan	1330	1315
	May	1565	1825		Feb	1320	1352
	Jun	1630	1644		Mar	1329	1352
	Jul	1586	1658		Apr	1321	1359
	Aug	1352	1627		May	1400	1354
	Sep	1175	1437		Jun	1250	1415
	Oct	1148	1257		Jul	1239	1311
	Nov	1258	1197		Aug	1451	1279
	Dec	1499	1269		Sep	1531	1438
2001	Jan	1393	1474		Oct	1620	1536
	Feb	1309	1435		Nov	1613	1626
	Mar	1650	1361		Dec	1580	1641
	Apr	1600	1612	2005	Jan	1680	1618
	May	1810	1627		Feb	1700	1691
	Jun	1881	1795		Mar	1686	1723
	Jul	2160	1887		Apr	1958	1719
	Aug	1480	2125		May	1553	1931
	Sep	1713	1646		Jun	2207	1660
	Oct	1687	1723		Jul	2106	2112
	Nov	1661	1720		Aug	1785	2132
	Dec	1632	1699		Sep	1885	1886
2002	Jan	1647	1671		Oct	2019	1910
	Feb	1901	1677		Nov	2499	2020
	Mar	1900	1877		Dec	2559	2419
	Apr	1790	1920	2006	Jan	2486	2553
	May	1926	1843		Feb	2641	2526
	Jun	1645	1933		Mar	2989	2641
	Jul	1350	1733		Apr	2959	2938
	Aug	1594	1458		May	3059	2979
	Sep	1705	1589		Jun	2548	3066
	Oct	1763	1705		Jul	2371	2686
	Nov	1735	1775		Aug	2721	2465
	Dec	1666	1769		Sep	3175	2690
2003	Jan	1492	1713		Oct	2976	3094
	Feb	1953	1565		Nov	2841	3027
	Mar	1856	1893		Dec	2836	2906
	Apr	1751	1889	2007	Jan	3259	2876
	May	1691	1806		Feb	3069	3200
	Jun	1797	1741		Mar	3009	3122
	Jul	1496	1810		Apr	2839	3059
	Aug	1265	1589		May	2742	2912
	Sep	1240	1361		Jun	2627	2804
	Oct	1215	1291		Jul	2051	2690
	Nov	1128	1256		Aug	2241	2215
	Dec	1321	1181		Sep	1979	2260
Year	**Month**	**Actual price**	**Predicted price**	**Year**	**Month**	**Actual price**	**Predicted price**
	Oct	1861	2065		Jul	2689	2889
	Nov	1755	1930		Aug	3609	2758

	Dec	1839	1818		Sep	3449	3448
2008	Jan	1959	1859		Oct	3109	3474
	Feb	2069	1962		Nov	3359	3213
	Mar	1969	2070		Dec	3089	3352
	Apr	1949	2016	2012	Jan	3339	3171
	May	2019	1988		Feb	2949	3327
	Jun	2219	2037		Mar	2819	3056
	Jul	2464	2204		Apr	2639	2896
	Aug	2279	2432		May	2489	2720
	Sep	2229	2337		Jun	2468	2564
	Oct	2759	2277		Jul	3069	2514
	Nov	2339	2679		Aug	3959	2973
	Dec	2392	2438		Sep	3959	3768
2009	Jan	3129	2427		Oct	4692	3942
	Feb	3164	3001		Nov	4919	4553
	Mar	2639	3153		Dec	3829	4864
	Apr	2114	2776	2013	Jan	4862	4080
	May	1589	2283		Feb	4089	4716
	Jun	3269	1765		Mar	4589	4251
	Jul	3809	2966		Apr	4939	4540
	Aug	3489	3650		May	4259	4877
	Sep	4189	3549		Jun	4159	4419
	Oct	5469	4074		Jul	4559	4241
	Nov	5899	5189		Aug	3850	4514
	Dec	4509	5769		Sep	3701	4020
2010	Jan	5709	4809		Oct	4529	3795
	Feb	4419	5537		Nov	5083	4394
	Mar	5029	4688		Dec	4959	4957
	Apr	6459	4979	2014	Jan	4999	4983
	May	6059	6161		Feb	6089	5020
	Jun	6009	6106		Mar	5779	5881
	Jul	4609	6055		Apr	6379	5826
	Aug	3589	4949		May	6301	6283
	Sep	3409	3911		Jun	5859	6322
	Oct	3434	3543		Jul	5219	5985
	Nov	3069	3483		Aug	6009	5411
	Dec	3392	3184		Sep	5439	5903
2011	Jan	3761	3371		Oct	5339	5565
	Feb	3789	3701		Nov	6749	5413
	Mar	3729	3795		Dec	6009	6482
	Apr	3559	3768	2015	Jan	6519	6137
	May	3789	3629		Feb	6689	6162
	Jun	2609	3779		Mar	5866	6187

Table 4: Ex-ante and ex-post forecast of greengram prices in Thandur market

Year	Month	Actual price	Predicted price	Year	Month	Actual price	Predicted price
2000	Apr	1320	-	2004	Jan	1400	1412
	May	1422	1388		Feb	1365	1435
	Jun	1487	1444		Mar	1475	1417
	Jul	1350	1505		Apr	1410	1489
	Aug	1245	1426		May	1325	1464

	Sep	1285	1330		Jun	1370	1397
	Oct	1300	1331		Jul	1290	1410
	Nov	1350	1342		Aug	1300	1357
	Dec	1350	1380		Sep	1710	1349
2001	Jan	1440	1391		Oct	1675	1634
	Feb	1470	1457		Nov	1650	1690
	Mar	1540	1497		Dec	1630	1689
	Apr	1583	1557	2005	Jan	1675	1674
	May	1626	1604		Feb	1800	1702
	Jun	1669	1647		Mar	1785	1797
	Jul	1200	1690		Apr	1960	1814
	Aug	1220	1374		May	1805	1941
	Sep	1322	1298		Jun	1837	1868
	Oct	1449	1348		Jul	2060	1870
	Nov	1889	1451		Aug	1951	2027
	Dec	1790	1788		Sep	1840	1995
2002	Jan	1400	1815		Oct	2200	1908
	Feb	1450	1549		Nov	2500	2136
	Mar	1650	1509		Dec	2400	2410
	Apr	1665	1637	2006	Jan	2600	2418
	May	1800	1684		Feb	2701	2560
	Jun	1550	1792		Mar	3200	2671
	Jul	1550	1648		Apr	2750	3052
	Aug	1750	1607		May	3300	2845
	Sep	1775	1735		Jun	2800	3172
	Oct	1675	1789		Jul	2500	2914
	Nov	1985	1734		Aug	2500	2631
	Dec	2100	1936		Sep	3000	2551
2003	Jan	1860	2073		Oct	2870	2878
	Feb	2020	1944		Nov	2750	2880
	Mar	2000	2020		Dec	3000	2796
	Apr	1965	2027	2007	Jan	3050	2948
	May	1875	2005		Feb	3000	3026
	Jun	1920	1936		Mar	2825	3013
	Jul	1897	1947		Apr	2750	2886
	Aug	1521	1935		May	2650	2798
	Sep	1250	1668		Jun	2550	2703
	Oct	1330	1402		Jul	2375	2606
	Nov	1370	1383		Aug	2016	2456
	Dec	1370	1406		Sep	1975	2162
Year	**Month**	**Actual price**	**Predicted price**	**Year**	**Month**	**Actual price**	**Predicted price**
	Oct	2025	2050		Jul	3430	3546
	Nov	1950	2053		Aug	3565	3461
	Dec	1875	2002		Sep	3700	3532
2008	Jan	2000	1935		Oct	3325	3646
	Feb	2050	2003		Nov	3200	3416
	Mar	2125	2058		Dec	3150	3264
	Apr	2025	2126	2012	Jan	2800	3185
	May	1800	2075		Feb	3500	2918
	Jun	2100	1903		Mar	2600	3332
	Jul	2600	2064		Apr	3000	2820

	Aug	2625	2460		May	3050	2954
	Sep	2550	2590		Jun	3250	3027
	Oct	2650	2574		Jul	3300	3188
	Nov	2700	2640		Aug	4251	3269
	Dec	2710	2693		Sep	3800	3958
2009	Jan	2600	2715		Oct	4000	3837
	Feb	3050	2645		Nov	4751	3943
	Mar	3290	2940		Dec	4700	4499
	Apr	3525	3191	2013	Jan	4875	4621
	May	3712	3427		Feb	4100	4778
	Jun	3625	3625		Mar	5131	4280
	Jul	4390	3620		Apr	4976	4860
	Aug	5016	4155		May	5000	4917
	Sep	4475	4744		Jun	4950	4949
	Oct	5300	4533		Jul	4960	4924
	Nov	6200	5051		Aug	4425	4923
	Dec	6021	5828		Sep	4800	4549
2010	Jan	5804	5923		Oct	4830	4705
	Feb	5200	5798		Nov	5325	4770
	Mar	5450	5339		Dec	5500	5135
	Apr	6600	5384	2014	Jan	6501	5361
	May	6300	6202		Feb	3900	6126
	Jun	6100	6224		Mar	6610	4522
	Jul	4250	6090		Apr	6600	5965
	Aug	3641	4757		May	6960	6367
	Sep	3425	3952		Jun	6005	6733
	Oct	2839	3573		Jul	5950	6168
	Nov	2899	3055		Aug	6300	5969
	Dec	2841	2950		Sep	5180	6158
2011	Jan	3810	2880		Oct	5455	5427
	Feb	4258	3539		Nov	7100	5413
	Mar	4100	4039		Dec	6231	6560
	Apr	4150	4070	2015	Jan	5100	6277
	May	3500	4114		Feb	4750	6230
	Jun	3500	3671		Mar	4750	6183

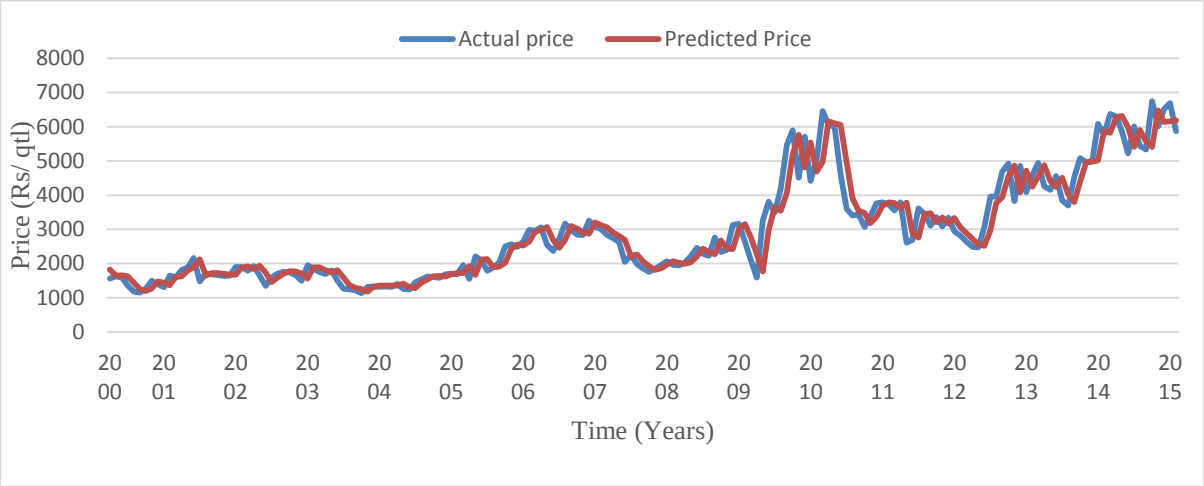

Fig. 1: Ex-ante and ex-post forecast of greengram prices in Suryapeta market

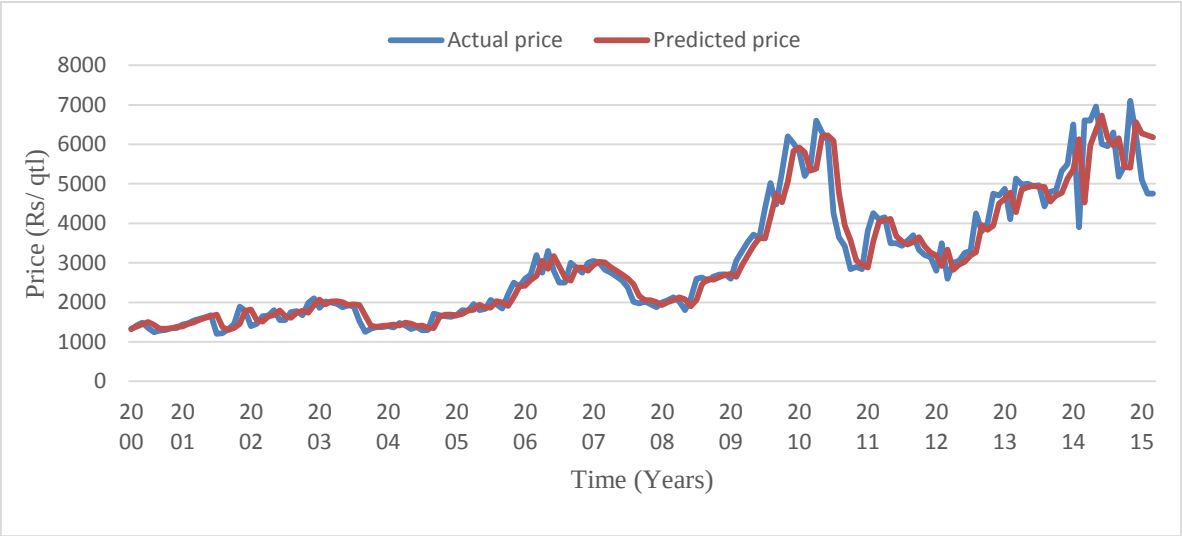

Fig. 2: Ex-ante and ex-post forecast of greengram prices in Thandur market

CONCLUSION

The forecasted prices of selected commodities were almost similar to actual prices with very good validation. Therefore, the ARIMA model serves as a good technique for predicting the magnitude of any variable. When the forecasts were compared with the real time prices, it was observed that there was less deviation in greengram. Forecasting of prices can be of great help to poor farmers in deciding what to cultivate and when to sell. This paper applied forecasting models to analyze farm produce price so that market players can be guided according to market changes, and therefore farmers, peasant brokers, enterprises as well as government can make decisions in relation to price forecast and market adjustment in a more rational way. Forecasting of future greengram prices can help the farmers to decide the area allocation for greengram and marketing. Besides this, the farmers can also take the decision of marketing of stored greengram immediately or after some months.

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