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Forecasting Monthly Prices of Bengalgram in Selected Markets of Andhra Pradesh

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***Abstract* – This paper attempts forecasting the monthly prices of bengalgram in selected markets of Andhra Pradesh through fitting of univariate Auto Regressive Integrated Moving Averages (ARIMA) models. The secondary data pertaining to monthly prices (Rs/Qtls) of bengalgram collected from April 2000 to December 2014 has been used for the study. For bengalgram in Koilakuntla the ARIMA (1, 1, 1) model, Kurnool (0, 1, 1) model fits the data well with lowest percentage error. Forecasts were found fairly accurate when compared with real time prices.**

***Keywords* – ARIMA, AIC and SBC, Bengalgram Prices, Forecasting.**

I. INTRODUCTION

Forecasting agricultural commodity prices could help decision makers to take decisions, which involve long-term commitments of resources e.g. agricultural producers, businesses that require agricultural products as inputs in production processes, financial institutions involved in portfolio-risk management, among others. It is known that the more accurate the forecast is, the more the benefits (in terms of greater utility) a decision-maker can obtain from it. Time series forecasting is a major challenge in many real world applications and this type of forecasting is to predict the values of a continuous variable (called as response variable or output variable) with a forecasting model based on historical data. A better understanding of commodity prices is necessary to construct good policy agencies shape policies and decide on which products require more focus. At the producer level, understanding commodity prices helps individual farmer to make key decisions about which crops to plant. The need to understand the complexity of commodity price dynamics has become more urgent against the backdrop of current tendencies to remove traditional governmental stabilization schemes (i.e. price bands and market intervention) in favour of transactions on globalized markets. There are a number of methods to generate prediction ranging in intuitive judgments through time-series analysis to econometric models. Weiss (2000) concluded that an Auto Regressive Integrated Moving Average (ARIMA) is most common for forecasting prices of commodity.

Pulses, the food legumes, have been grown since millennia and have been a vital ingredient of the human diet in India; as such has long been considered as the poor man's only source of protein. Pulses are one of the important segments of human diet in Indian subcontinent along with cereals and oilseeds. The split grains of pulses, called dal are excellent source of high quality protein, essential amino and fatty acids, fibers, minerals and vitamins. These crops improve soil health by enriching nitrogen status, long-term fertility and sustainability of the cropping systems. India being the largest producer (18.5 million tonnes) and processor of pulses in the world. It also imports around 3.5 million tonnes annually on an average to meet its ever increasing consumption needs of around 22.0 million tonnes (Singh 2015). Among the pulses, bengal gram is widely appreciated as health food. It is a protein-rich supplement to all cereal based diet, especially for vegetarians. In India, bengal gram is one of the most widely grown pulse crops. It was cultivated over an area of 8250.5 thousand hectares with a production of 7331.8 thousand tonnes and yield of 889 kgs. per hectare in 2014-15. In Andhra Pradesh, bengal gram is one of the most widely grown pulse crops. It was cultivated over an area of 342 thousand hectares with a production of 391 thousand tonnes and productivity of 1143 kgs. per hectare in 2014-15.

II. METHODOLOGY

The ARIMA model of price forecasting was used to forecast the prices of Bengal gram. Two markets were selected based on the average arrivals of the three years i.e., 2011 to 2014. The two markets selected for bengal gram are Koilakuntla and Kurnool. The monthly modal prices for 14 years from the selected markets of bengalgram were collected to predict the prices 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 $Y_{t-1}, Y_{t-2}, Y_{t-3}, \ldots, Y_{t-p}$. 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.

III. Results and Discussion

Forecasting Prices of Bengal Gram in Koilakuntla and Kurnool Market

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 (1, 1, 1) in koilakunta and the model (0, 1, 1) was found as the best model in Kurnool market.

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

Market	Model	AIC	SBC
Koilakuntla	111	2486.0749	2495.5864
Kurnool	011	2564.5073	2570.8483

Table 2 : ACF and PACF values of monthly prices of bengal gram in Koilakuntla and Kurnool markets

ACF and PACF of monthly prices of bengal gram in Koilakuntla market (111)		
Lags	**ACF**	**PACF**
1	.006	.006
2	-.052	-.052
3	.073	.074
4	.015	.011
5	-.172	-.166
6	.141	.146
7	.123	.105
8	-.236	-.222
9	.146	.174
10	.025	-.051
11	-.047	.022
12	.073	.110
13	.039	-.110
14	-.237	-.147
15	-.042	-.002
16	.063	-.053

ACF and PACF of monthly prices of bengal gram in Kurnool market (011)		
Lags	**ACF**	**PACF**
1	-.020	-.020
2	-.001	-.001
3	.027	.027
4	.040	.041
5	-.055	-.054
6	.036	.033
7	.053	.053
8	-.013	-.010
9	.120	.124
10	.071	.069
11	-.019	-.016
12	-.149	-.154
13	.138	.119
14	-.033	-.022
15	-.033	-.027
16	-.073	-.093

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 Koilakuntla and Kurnool markets are presented in Table 3and 4 and illustrated in Fig. 1 and 2. As it can be seen from the graph that the actual and forecasted prices of Bengal gram in the selected markets were more or less closer. According to the forecasts the price of Bengal gram in Koilakuntla market would be ranging from Rs.2788 to Rs.2830 per quintal and in Kurnool market would be ranging from Rs.2565 to Rs.2583 per quintal for the months from January to March 2015. Mathur and Singh (2017) studied the impact of pre sowing price forecast of chickpea and revealed that ARIMA (1, 1, 1) was used and forecasted prices. The impact assessment of price forecast was done on 20 adopter farmers of Bikaner. Thus, a significant acreage increase and an incremental income realized to the extent of Rs.17001.6 per hectare by the farmers.

Table 3: Ex-ante and ex-post forecast of bengal gram prices in Koilakuntla market

Year	Month	Actual price	Predicted price	Year	Month	Actual price	Predicted price
2000	Apr	800	-	2004	Jan	1300	1303
	May	800	811		Feb	1300	1310
	Jun	900	815		Mar	1300	1315
	Jul	900	883		Apr	1400	1318
	Aug	800	897		May	1400	1382
	Sep	800	844		Jun	1500	1397
	Oct	800	836		Jul	1500	1468
	Nov	900	832		Aug	1600	1488
	Dec	900	891		Sep	1600	1563
2001	Jan	1100	902		Oct	1700	1584
	Feb	1200	1034		Nov	1700	1660
	Mar	1100	1128		Dec	1700	1683
	Apr	1200	1100	2005	Jan	1600	1697
	May	1200	1170		Feb	1600	1644
	Jun	1300	1189		Mar	1500	1637
	Jul	1300	1264		Apr	1200	1570
	Aug	1400	1285		May	1300	1366
	Sep	1400	1361		Jun	1600	1378
	Oct	1400	1383		Jul	1700	1545
	Nov	1300	1397		Aug	1400	1635
	Dec	1300	1344		Sep	1700	1480
2002	Jan	1300	1337		Oct	1300	1646
	Feb	1300	1332		Nov	1400	1425
	Mar	1300	1329		Dec	1600	1451
	Apr	1300	1327	2006	Jan	1600	1566
	May	1300	1326		Feb	1700	1586
	Jun	1300	1325		Mar	1700	1662
	Jul	1200	1324		Apr	1800	1684
	Aug	1200	1262		May	1900	1760
	Sep	1300	1248		Jun	1900	1845
	Oct	1300	1301		Jul	1900	1873
	Nov	1300	1309		Aug	2000	1891
	Dec	1400	1314		Sep	2000	1965
2003	Jan	1400	1380		Oct	2100	1985
	Feb	1300	1395		Nov	2100	2061
	Mar	1300	1343		Dec	2100	2083
	Apr	1400	1336	2007	Jan	2000	2097
	May	1400	1394		Feb	2000	2044
	Jun	1300	1404		Mar	2200	2037
	Jul	1300	1349		Apr	2100	2157
	Aug	1300	1340		May	2100	2118
	Sep	1300	1334		Jun	2100	2120
	Oct	1200	1330		Jul	2200	2121
	Nov	1200	1265		Aug	2200	2184
	Dec	1300	1250		Sep	2300	2198
	Oct	2400	2269		Jul	2200	2539
	Nov	2400	2351		Aug	2500	2427
	Dec	2400	2377		Sep	2500	2541
2008	Jan	2300	2393		Oct	2500	2535
	Feb	2200	2342		Nov	4600	2531
	Mar	2200	2273		Dec	2900	3836
	Apr	2100	2255	2012	Jan	3200	3057
	May	2100	2182		Feb	3300	3196
	Jun	2100	2161		Mar	3600	3268
	Jul	2200	2147		Apr	3600	3475
	Aug	2200	2201		May	3700	3527
	Sep	2300	2209		Jun	3600	3624
	Oct	2300	2276		Jul	3600	3597
	Nov	2200	2293		Aug	5100	3606
	Dec	2300	2241		Sep	4850	4547
2009	Jan	2400	2297		Oct	4450	4596
	Feb	2400	2369		Nov	4850	4445
	Mar	2300	2388		Dec	4600	4704
	Apr	2300	2338	2013	Jan	3800	4609
	May	2300	2333		Feb	3500	4116
	Jun	2400	2330		Mar	3400	3825
	Jul	2400	2390		Apr	3400	3655
	Aug	2400	2402		May	3400	3573
	Sep	2300	2409		Jun	3300	3520
	Oct	2300	2352		Jul	3300	3423

Year	Month	Actual price	Predicted price	Year	Month	Actual price	Predicted price
	Nov	2400	2342		Aug	3200	3388
	Dec	2400	2397		Sep	3400	3303
2010	Jan	2300	2407		Oct	3400	3399
	Feb	2200	2350		Nov	3400	3408
	Mar	2200	2278		Dec	3100	3413
	Apr	2400	2259	2014	Jan	3100	3230
	May	2400	2371		Feb	2800	3192
	Jun	2500	2389		Mar	2800	2981
	Jul	2500	2464		Apr	2800	2925
	Aug	2600	2485		May	2800	2889
	Sep	2600	2561		Jun	2800	2865
	Oct	2700	2583		Jul	2800	2850
	Nov	2600	2660		Aug	2900	2841
	Dec	2500	2620		Sep	2850	2897
2011	Jan	2400	2559		Oct	2850	2875
	Feb	2300	2484		Nov	2816	2874
	Mar	2300	2400		Dec	2719	2853
	Apr	3500	2373	2015	Jan	3250	2788
	May	3500	3103		Feb	3500	2814
	Jun	2200	3252		Mar	3500	2830

Table 4 : Ex-ante and ex-post forecast of bengal gram prices in Kurnool market

Year	Month	Actual price	Predicted price	Year	Month	Actual price	Predicted price
2000	Apr	900	-	2004	Jan	1300	1190
	May	900	909		Feb	1300	1246
	Jun	1050	913		Mar	1250	1278
	Jul	1100	986		Apr	1350	1275
	Aug	1100	1045		May	1350	1316
	Sep	1050	1078		Jun	1500	1340
	Oct	1050	1075		Jul	1475	1417
	Nov	1100	1074		Aug	1500	1451
	Dec	1000	1094		Sep	1500	1481
2001	Jan	1100	1063		Oct	1700	1498
	Feb	1100	1088		Nov	1700	1593
	Mar	1200	1102		Dec	1600	1647
	Apr	1200	1153	2005	Jan	1575	1636
	May	1250	1182		Feb	1530	1620
	Jun	1100	1220		Mar	1575	1591
	Jul	1100	1178		Apr	1600	1593
	Aug	1300	1154		May	1650	1605
	Sep	1300	1225		Jun	1700	1633
	Oct	1300	1266		Jul	1800	1671
	Nov	1400	1290		Aug	1820	1735
	Dec	1100	1345		Sep	1850	1780
2002	Jan	1100	1251		Oct	1855	1819
	Feb	1300	1196		Nov	2050	1843
	Mar	1300	1249		Dec	1731	1940
	Apr	1250	1280	2006	Jan	1711	1861
	May	1200	1276		Feb	1561	1806
	Jun	1200	1253		Mar	1608	1712
	Jul	1300	1240		Apr	1703	1677
	Aug	1300	1274		May	1355	1697
	Sep	1375	1294		Jun	1526	1561
	Oct	1300	1338		Jul	2089	1556
	Nov	1300	1331		Aug	2200	1791
	Dec	1300	1327		Sep	2800	1973
2003	Jan	1300	1325		Oct	2800	2333
	Feb	1200	1323		Nov	2700	2540
	Mar	1150	1280		Dec	2510	2617
	Apr	1100	1234	2007	Jan	2088	2581
	May	1100	1187		Feb	2009	2381
	Jun	1250	1159		Mar	2016	2233
	Jul	1250	1207		Apr	2269	2150
	Aug	1300	1234		May	2216	2210
	Sep	1300	1271		Jun	2131	2221
	Oct	1200	1293		Jul	2296	2192
	Nov	1100	1263		Aug	2326	2245
	Dec	1150	1203		Sep	2290	2289
	Oct	1716	2298		Jul	2769	2391

Year	Month	Actual price	Predicted price	Year	Month	Actual price	Predicted price
	Nov	2100	2061		Aug	1909	2560
	Dec	1700	2087		Sep	3875	2294
2008	Jan	1741	1932		Oct	3420	2973
	Feb	2316	1860		Nov	3629	3171
	Mar	2269	2062		Dec	2120	3374
	Apr	2004	2159	2012	Jan	3480	2852
	May	2065	2103		Feb	3341	3127
	Jun	2100	2096		Mar	3659	3227
	Jul	2300	2107		Apr	3890	3419
	Aug	2300	2198		May	4440	3628
	Sep	2280	2250		Jun	4139	3981
	Oct	2100	2272		Jul	4010	4057
	Nov	2100	2208		Aug	4810	4046
	Dec	2030	2172		Sep	2300	4379
2009	Jan	1900	2121		Oct	3830	3508
	Feb	1966	2036		Nov	4826	3653
	Mar	1726	2016		Dec	3766	4159
	Apr	1902	1902	2013	Jan	3360	4002
	May	1769	1911		Feb	3429	3739
	Jun	1849	1860		Mar	3349	3617
	Jul	2391	1865		Apr	3431	3513
	Aug	2157	2097		May	3180	3487
	Sep	1570	2131		Jun	3050	3366
	Oct	2100	1903		Jul	2809	3241
	Nov	1950	1995		Aug	2609	3067
	Dec	2106	1985		Sep	2869	2882
2010	Jan	2044	2046		Oct	2450	2886
	Feb	1930	2054		Nov	2819	2710
	Mar	1820	2011		Dec	2369	2766
	Apr	2000	1939	2014	Jan	2700	2607
	May	1610	1974		Feb	2690	2655
	Jun	1889	1829		Mar	2659	2679
	Jul	1709	1864		Apr	2585	2680
	Aug	1729	1807		May	2589	2649
	Sep	1609	1783		Jun	2410	2633
	Oct	1520	1719		Jul	2400	2547
	Nov	2150	1644		Aug	2000	2494
	Dec	1949	1867		Sep	2110	2294
2011	Jan	2251	1911		Oct	2059	2225
	Feb	2360	2064		Nov	2020	2164
	Mar	2260	2199		Dec	3160	2112
	Apr	2269	2234	2015	Jan	3202	2565
	May	2289	2258		Feb	3447	2574
	Jun	2521	2280		Mar	3270	2583

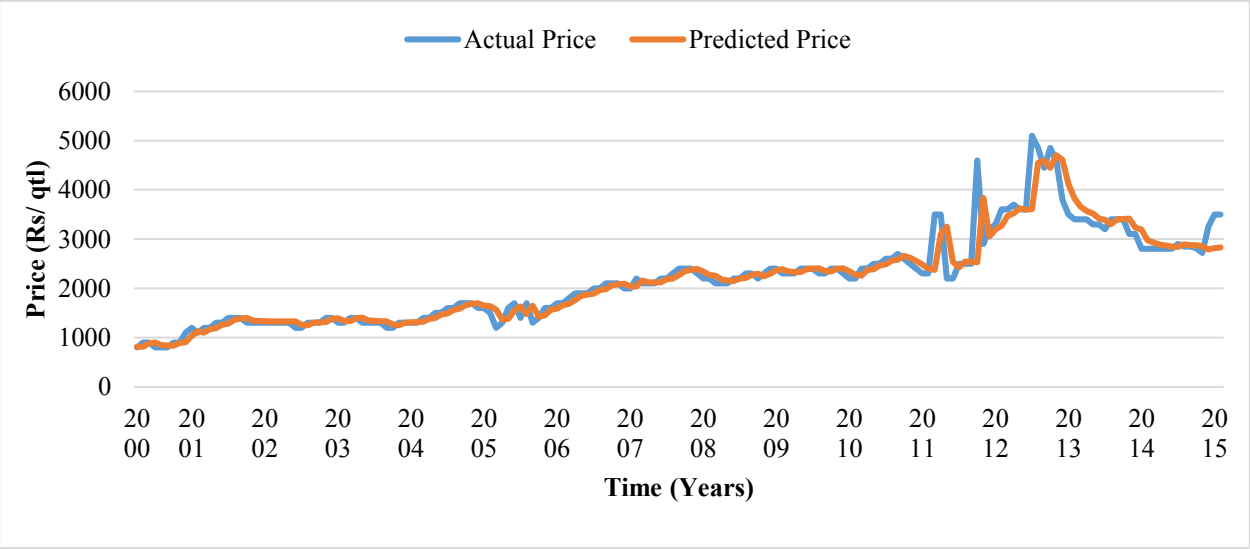

Fig. 1. Ex-ante and ex-post forecast of bengal gram prices in Koilakuntla market

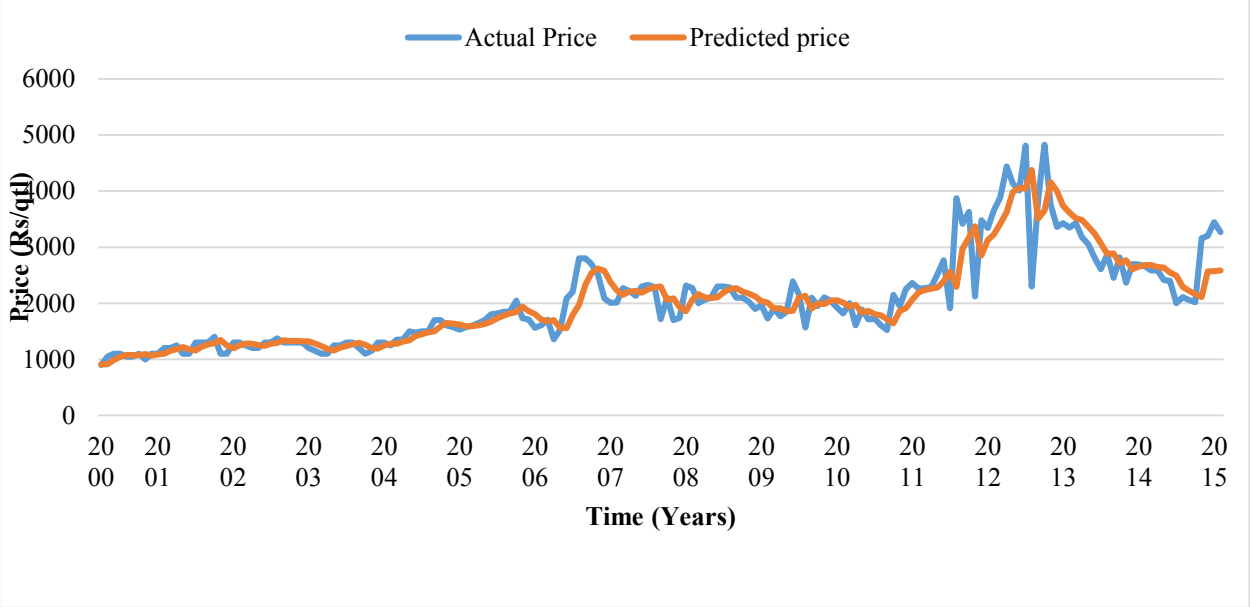

Fig. 2. Ex-ante and ex-post forecast of bengal gram prices in Kurnool market

IV. Conclusion

When the forecasts were compared with the real time prices, it was observed that there was less deviation. Forecasting of prices can be of great help to poor farmers in deciding what to cultivate and when to sell. This will certainly help in reducing the exploitation of farmers by the middlemen and will uplift the socio-economic status of the poor farmers.

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