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RESEARCH PAPER

Price behavior and forecasting of groundnut prices in Hubballi and Raichur markets of Karnataka State

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Abstract: The present study is mainly focused to analyse the behavior of groundnut prices in Hubballi and Raichur markets in Karnataka and forecasting the prices for the future. Based on secondary data from January 2007 to July 2022, the future prices were predicted for the next six months of current 2022, by employing the Auto Regressive Integrated Moving Average (ARIMA) technique. The annual increase in prices of groundnut in Hubballi and Raichur markets were observed to be ₹ 172.2 and 250.4 per quintal per annum, meanwhile there is a decrease in Arrivals. The highest seasonal index was observed in the month of November and lowest seasonal index was recorded in January for Hubball. Similarly high seasonal index was observed in the month of March and lowest in October for Raichur Market. Mainly Two and Three price cycles were noticed for groundnut prices in Hubballi and Raichur Market, respectively. Maximum R-Square (0.81), (0.89), minimum Mean Absolute Percentage Error (MAPE) (10.22), (8.91), Root Mean Square Error (RMSE) (432.76), (429.17), Mean Absolute Error (MAE) (311.92), (309.62) and Normalized BIC (12.22) and (12.23), respectively for Hubballi and Raichur, were used as a criteria to select the best model for price forecasting. Based on the criteria the model (0,1,3) (0,0,0) and (1,1,1) (0,0,1) were found to fit the time series to predict future prices. The forecasted price of groundnut would be ranging from ₹ 4182 to 4390 and ₹ 5186 to 5538 per quintal during the cram months in Hubballi and Raichur markets, respectively.

Key words: ARIMA technique, Normalized BIC, Price forecasting, Seasonal indices, Trend

Introduction

Groundnut has become an important edible oilseed crop for dietary consumptions as a part of the Indian diet and also its prices are moderately volatile. Groundnut price fluctuations are occurring all over Indian markets and they are causing damage to both groundnut producers and consumers. The ARIMA model is commonly used in price time series prediction, especially for series that has a cyclic or seasonal pattern. At the same time, Box-Jenkins ARIMA model will give the good representation of short time forecasting. The principle of the model contains filtering out the high-frequency noise in the data, detecting local trends based on liner dependence and forecasting the trends. Despite its high predictive performance, the model has some limitations which decrease its scope of application. The model assumes a linear relationship between the dependent and independent variables while the actual data often present in non-linear relationships. Besides, the model assumes that the mean and variance of the response series are independent of time, which means stationary. Thus, more than one model should be tested to choose a better one. Forecasting of prices of perishable agricultural commodities is very difficult because they are not only governed by demand and supply but also by so many other factors which are beyond control like weather vagaries, storage capacity, transportation *etc*. Chahal *et al.* (2004) examined the price behaviour of green peas in Hoshiarpur and Ludhiana (Punjab) markets from 1994 to 2002. Sangeeta (2004) analyzed the behaviour of arrivals and prices of onion in Lasalgaon and Pune markets (Maharashtra) from 1999-2002. Devi *et al.* (2016) studied the price behaviour of chillies in Guntur market of Andhra Pradesh, India for the years 1997-2014. ARIMA model was employed by Darekar *et al.* (2016) to forecast the prices of onion at Lasalgaon market of Western Maharashtra.

The main objective of present research was to analyse the price behaviour and forecasting of groundnut prices in Hubballi and Raichur markets of Karnataka state.

Material and methods

The time series data on monthly prices of groundnut required for the study was collected from the registers maintained by the respective market APMCs, Krushimaratavahini and Agmarknet. The data related to monthly modal prices (₹ /qtl) for the period from January 2007 to September 2022 was used for time series analysis and for price forecasting from July to December 2022.

To analyse all the four components of a time series *viz.,* trend, seasonal, cyclical and irregular fluctuations, a multiplicative model of the following type was used as elucidated in Areef *et al.* (2019),

Monthly data $Yt = Tt \times St \times Ct \times It$

where,

Yt = Time series data on prices at time period 't'

Tt = Trend component at time period 't'

St = Seasonal variations at time period 't'

Ct = Cyclical movements at time period 't'

It = Irregular fluctuations at time period 't'

Trend component

Over a long period, time series is likely to show tendency to either increase or decrease over time. Price trend explains the general direction of the movement of prices over long period of time. Ordinary least square method was employed to ascertain the trend in prices by estimating the intercept (a) and slope coefficient (b) in the following linear functional form:

$Yt= a + bXt + et$

where,

Yt = Trend value at time t

Xt = period (Serial number assigned to the tth month)

et = Random disturbance term (assumption of zero mean and constant variance)

a = Intercept parameter

b = Slope parameter

The goodness of fit of trend line to the data was tested by computing the multiple coefficient of determination (R2).

Seasonal variations

In order to estimate the seasonal variation, the twelve month centered moving average method was used which gives us the periodic changes without seasonality. To estimate the seasonal index, a 12 month centered moving average was calculated as follows:

$M1 = Y1 + Y2 + Y3 + ….. + Y12 / 12$

$M2 = Y2 + Y3 + Y4 + ….. + Y13 / 12$

$M3 = Y3 + Y4 + Y5 + ….. + Y14 / 12$ ………*etc.*

This is sequential manner for each points of time t. In this fashion, a 12 month centered moving average removes a large part of fluctuation due to the seasonal effects so that what remains is mainly attributable to other sources *viz.,* long term effects Tt, cyclical effect Ct and the irregular variation It which is due to random causes is also minimized by the process of smoothing out effect.

$St = Y/ (TC)t= Tt^* Ct^* St^*It / Tt^* Ct$

It is always expressed in terms of percentages. In this process, we do not have moving average for the first six and last six months. These seasonal components are next arranged month-wise for each year. The last row in the study give estimates of seasonal index for the 12 months adjusted for their total to 1200 or averaged to 100.

$(TCI)t = Yt / St = (TCSI)t / St$

Cyclical movements

Cyclical variations are long term oscillatory movements with duration of greater than one year. The most commonly used method for estimating cyclical movement of time series is the residual method by eliminating the seasonal variation and trend. This is accomplished by dividing (Yt) by corresponding (S) for time 't'

Symbolically,

$T.C.S.I/S$ and $T.C.I/T = C.I$

Auto regressive integrated moving average

Introduced by Box and Jenkins (1976), the ARIMA model has been one of the most popular approaches for forecasting. The ARIMA model is basically a data oriented approach that is adopted from the structure of the data itself. In an ARIMA model, the estimated value of a variable is supposed to be a linear combination of the past values and the past errors. Generally a time series can be modelled as a combination of past values and errors, which can be denoted as ARIMA (p,d,q) which is expressed in the following form

$Yt = \theta 0 + \Phi 1 Yt\text{-}1 + \Phi 2\, Yt\text{-}2 + ... + \Phi p\, Yt\text{-}p + et - \theta 1 et\text{-}1 - \theta 2\, et\text{-}2 - \theta et\text{-}q$

where Yt and et are the actual values and random error at time t, respectively, Φi ($i = 1,2,……, p$) and θj ($j = 1,2,……, q$) are model parameters, p and q are integers and often referred to as orders of autoregressive and moving average polynomials, respectively. Random errors are assumed to be independently and identically distributed with mean zero and constant variance. Similarly, a seasonal model is represented by ARIMA (p, d, q) × (P, D, Q), where P is the number of seasonal autoregressive (SAR) terms, D is the number of seasonal differences and Q is the number of seasonal moving average (SMA) terms. Basically this method has four steps identification of the model, estimating the parameters, diagnostic checking and forecasting

Results and discussion

The results revealed from Fig.1 to Fig.4, that there was an upward trends in prices of groundnut in Hubballi market (Y=1587.4+172.2t) and Raichur market (Y = 1302.7+250.4t) of Karnataka, On the other hand, revealed by negative slopes in the trend equation of Hubballi market (Y=10368.6-412.1t) and Raichur market (Y=19924.7-535.5t) of Karnataka, Two markets in each of the chosen instate for groundnut crop were subjected for in depth analysis. Linear trend analysis for price of groundnut indicated a positive trend in the selected markets. The prices of groundnut did increase in the selected markets, but the extent of increase in prices varied from market to market.

It could be observed from Table 1. that the prices in selected markets showed increasing trend. Among the chosen markets, Raichur market (₹ 250.4/qtl) registered the highest increasing trend in prices of groundnut. Over the years where the annual increment in prices was at the rate of ₹ 172.2 to ₹ 250.4 per quintal, the annual increment in prices was found to be the

Table 1. Trends in prices and arrivals of groundnut in selected markets in India during study period

States	Markets	Prices (₹)	R^2	Arivals(q)	R^2
Karnataka	Hubballi	Y = 1587.4+172.2**t	0.73	Y = 10368.6 -412.1**t	0.58
	Raichur	Y = 1302.7 + 250.4**t	0.90	Y = 19924.7 -535.5t	0.34

Note:** Significant at 1 per cent level

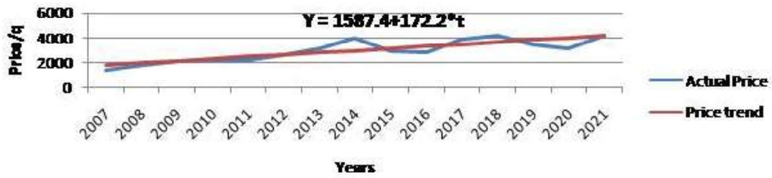

Fig.1. Trends in prices of groundnut in Hubballi market

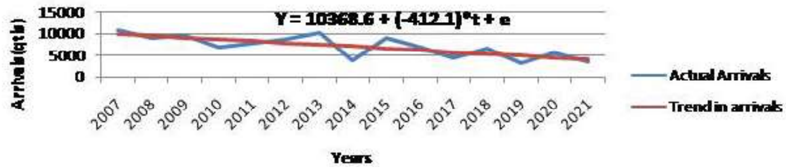

Fig.2. Trends in Arrivals of groundnut in Hubballi market

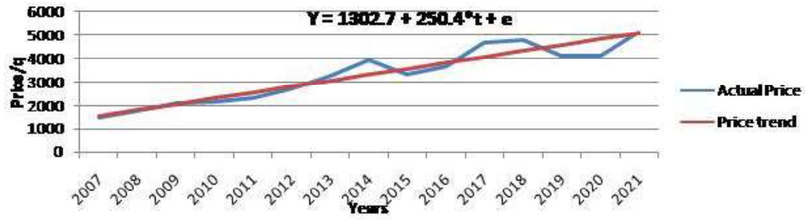

Fig.3. Trends in prices of groundnut in Raichur market

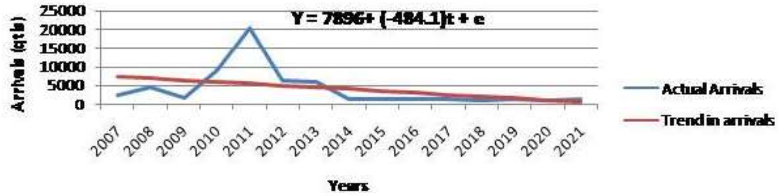

Fig.4. Trends in Arrivals of groundnut in Raichur market

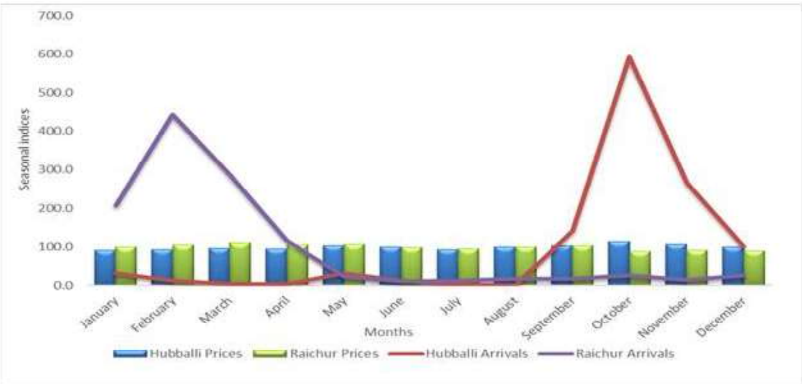

Fig. 5. Seasonal variations in arrivals and prices of groundnut in Hubballi and Raichur markets

lowest in Hubballi market (₹ 172.2/qtl). Since rate of arrivals decreased (Table1), even though the prices were at higher increment level.

It could be observed from the results presented in Table 2 that groundnut price indices in selected markets of Karnataka were higher in May, June, September, October, November and December (ranging from 103.4 to 114.2) in Hubballi market, whereas in Raichur market indices were higher during January to May months and August and September (ranging from100.01 to 110.9). The same is represented graphically in Fig. 5. The indices for groundnut arrival presented in the table indicated higher indices in the months of October (592.6) and November (267.0) for Hubballi market and January (206.9) to March (286.5) in Raichur market of Karnataka, with the highest indices during February (446.3).

Results revealed that the seasonal variations were observed in prices of groundnut in all the selected markets. When the arrivals of groundnut to the market were high, the prices were found to be high in Hubballi, However, in Raichur market, higher seasonal indices were found during the months of February to May with similar trend in indices of arrivals. This positive correlation between arrivals and price trend may be attributed to the fact that farmers are well aware of trend in market prices and commodity comes to these markets in anticipation of higher prices due to higher number of buyers and exhibition of perfect competition among buyers in the markets. The same pattern of positive correlation in Raichur market between arrivals and price of groundnut but during different months was due to fact of cultivation of groundnut during *rabi* season and also arrivals from Telangana and Andhra Pradesh. The variation in prices (as indicated by seasonal indices) may be due to the nature of production of groundnut, availability of storage facilities and processing facilities. The reason of immediate cash requirement by the farmers also compelled them to go for sale immediately after harvest.

For groundnut two price cycle were identified of which first cycle was of eight-years duration ranging from 2007 to 2013 and second cycle was seven- years duration ranging from 2014 to 2022 for Hubballi market. Where as Raichur market showed three cycles (Fig. 6), of which first cycle was of five-years duration from 2007 to 2012, second cycle of four -year duration from 2013 to 2018 and third cycle of seven -year

Table. 2. Seasonal indices for groundnut in selected markets of India during study period (Prices in Rs, Arrivals in qtls)

States	Karnataka			
Markets	Hubballi		Raichur	
Months	Prices	Arrivals	Prices	Arrivals
January	91.7	30.3	100.8	206.9
February	93.6	12.9	105.2	443.1
March	96.7	4.6	110.9	286.5
April	94.9	3.3	106.3	116.4
May	103.4	31.0	107.2	22.3
June	100.1	12.2	99.3	11.2
July	94.1	2.5	95.3	13.0
August	99.9	0.6	100.1	16.7
September	103.4	141.2	103.5	17.2
October	114.2	592.6	89.0	25.9
November	106.9	267.0	92.3	14.2
December	101.1	101.8	90.2	26.5

Table 3. ARIMA model to the prices of groundnut in selected markets

Markets	Fitted models	R^2	RMSE	MAPE	MAE	MaxAPE	MaxAE	Normalized BIC
Hubballi	(0,1,3)(0,0,0)	0.811	432.764	10.224	311.922	63.827	1801.198	12.221
Raichur	(1,1,1)(0,0,1)	0.891	429.179	8.915	304.622	45.611	1418.316	12.231

R^2 - Coefficient of determination
RMSE - Root Mean Square Error
MAPE - Mean Absolute Percentage Error
MAE - Mean Absolute Error
MaxAPE - Maximum Absolute Percentage Error
MaxAE - Maximum Absolute Error
BIC- Bayesian Information Criterion

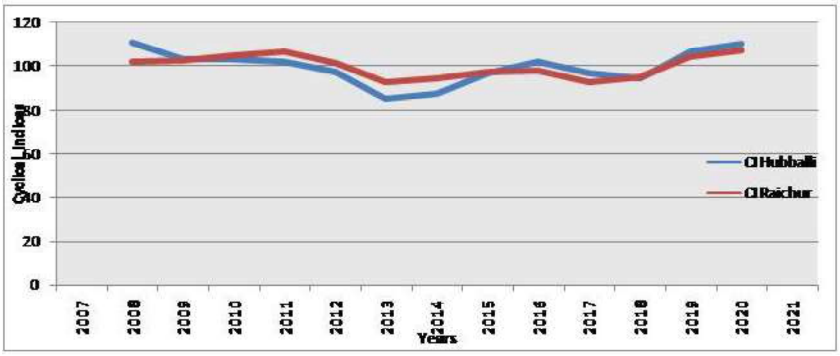

Fig.6. Cyclical variations in prices of groundnut in Hubballi and Raichur markets

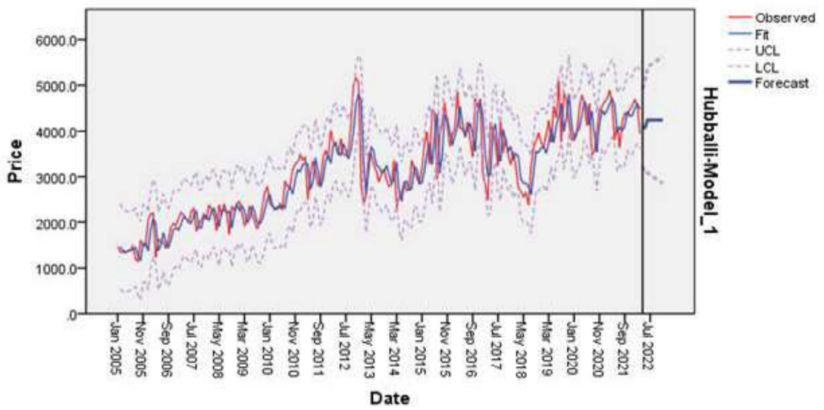

Fig. 7. Price forecast of groundnut from Hubballi market

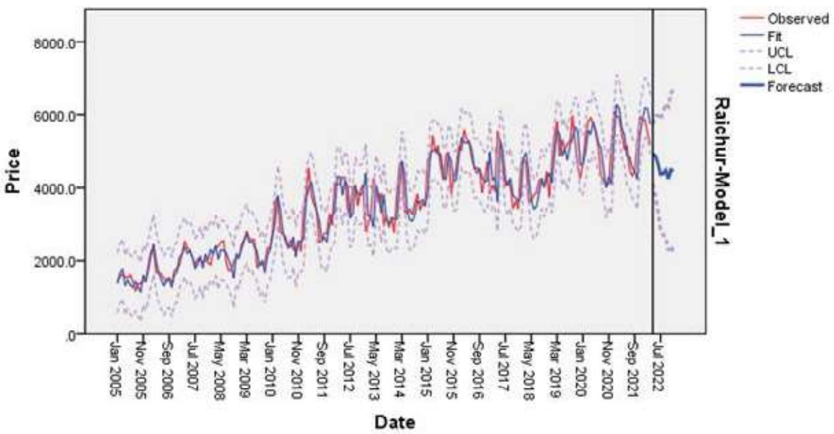

Fig. 8. Price forecast of groundnut from Raichur market

duration from 2019 to 2022. It could be observed that there existed uneven cycles in prices of groundnut for selected markets. Perfect cycles with regard to variations in prices could be observed if the time series data is for relatively lengthy period (for a period of about 35 to 40 years). Due to non availability of data for such a long period, researcher is unable to get the proper cyclical pattern with respect to prices

From the different (p, d, q) models, ARIMA model was selected based on the lowest MAPE and normalized BIC values for forecasting the prices of the oilseeds under study in different markets of Karnataka. The suitability of the forecasting model was judged based on the MAPE values, these values for groundnut market of Hubballi and Raichur, were 10.224, 8.915, with their respective normalized BIC values of 12.221, 12.231,. The model parameters were estimated using SPSS software and the best fitted models were used for forecasting. The results were presented from Table 3. The forecasted prices of groundnut in Hubballi showed increasing trend initially and then it was steady (Fig.7), while Raichur market (Fig.8) showed increasing trend.

In the present investigation a large scale comparison was done in order to know the best model for forecasting of prices of Groundnut. The models were fitted based on the MAPE and normalised BIC values which were considered to be least. The ARIMA model for groundnut in Hubballi, Raichur, showed the least MAPE values of 10.22, 8.91, respectively and corresponding BIC values of 12.22, 12.23, were considered to be the best among fit.

The forecast has been done for the prices of groundnut using ARIMA model for Hubballi and Raichur markets of Karnataka up to December 2022 (Table 4). Hence, farmers can take benefit of this by planning their production and sale of the produce during the months of high prices

Table 4. Price forecast for groundnut in Hubballi and Raichur markets of Karnataka

Markets	Hubballi					Raichur				
Month and Years	Actual Price	Forecasted Price	LCL Price	UCL Price	Deviation	Actual	Forecasted	LCL	UCL	Deviation
Jan-21	3800	3890	3036	4743	-90	4714	4646	3802	5491	68
Feb-21	3925	3992	3139	4845	-67	5429	5017	4173	5862	412
Mar-21	4460	4017	3163	4870	443	5814	5481	4636	6325	334
Apr-21	4790	4368	3515	5222	422	5908	5540	4695	6384	368
May-21	4647	4624	3771	5478	23	5748	5802	4958	6647	-54
Jun-21	4135	4466	3613	5319	-331	5504	5555	4711	6400	-51
Jul-21	4598	4117	3263	4970	481	5061	5486	4641	6330	-425
Aug-21	3495	4505	3652	5359	-1010	4309	5173	4329	6018	-864
Sep-21	3555	3793	2940	4647	-238	4201	4836	3992	5681	-635
Oct-21	4015	3646	2792	4499	369	4053	4502	3657	5346	-449
Nov-21	4462	4204	3351	5058	258	4119	4332	3488	5177	-213
Dec-21	4530	4397	3544	5250	133	5147	4463	3618	5307	684
Jan-22	4643	4361	3507	5214	282	6082	5246	4402	6091	836
Feb-22	4700	4479	3625	5332	222	5952	5955	5111	6800	-3
Mar-22	4889	4563	3709	5416	326	5926	5858	5014	6703	68
Apr-22	4602	4693	3840	5547	-91	5504	5857	5013	6702	-353
May-22	3804	4524	3670	5377	-720	5048	5485	4641	6330	-437
Jun-22	4100	3936	3082	4789	164	5166	5190	4345	6034	-24
Jul-22		4182	3328	5035			5186	4342	6031	
Aug-22		4342	3291	5393			5103	4089	6117	
Sep-22		4290	3140	5460			5107	4026	6188	
Oct-22		4360	3109	5491			5160	4050	6270	
Nov-22		4210	3078	5522			5256	4134	6379	
Dec-22		4390	3048	5552			5538	4409	6666	

Note: LCL-Lower Critical Limit: UCL- Upper Critical Limit

Conclusion

Reliable price forecast model enable the government to make appropriate decisions in advance like procurement, regulating export & imports and possibility of check on trader hoardings. The price seasonal indices and forecasted price information was more important for the farmer to selection of crop varieties, allocation of scarce inputs under different crops and adjusting the sowing & harvesting dates to get remunerative prices in a more rational way.

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